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Shiftwork Stress Resistance, Health & Performance: A Predictive, Integrative Model

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Shiftwork Stress Resistance, Health & Performance: A Predictive, Integrative Model

by

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Dedication

To my parents, Sandra and Ronald Lehrer, for their care, wisdom, and tender strength. My steps are forever shaped by your love. To my wife, Gema, for your soul, spirit, and love. My steps are forever stronger because of your beautiful voice. To my children, Sophia and Gëanna, for your hearts, smiles, and wondrous possibilities. My steps are forever happier knowing yours.

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you as we continue the journey. Skip ahead and I'll be longing for this period right now sitting at the keyboard on March 9th, 2005 at 1:*34 am. By now it must be 2020 or so, and I imagine it's been a great day. I hope these pages please you in years to come and inspire you to ask important and meaningful questions. Skip ahead and now I am an older man and the world will have made sense of many of the mysteries of my time – as it will for yours one day – some time after these thoughts meet your inquisitive minds. My hopes and prayers are that you, your children, and all those who follow beyond will be part of newer questions about this rhythm of life, love, and learning, and that you will be inspired to always ask questions. I wish you the thrill of wondering, the peace of knowing and not knowing, and the hopefulness of tomorrow's answers, always in rhythm. One more thing: "If no more be done, I know the joy. For I have played the blues note, and my heart cried." I wrote that approximately 15 years ago and wanted to include it as I believe science is the music of the mind, and music is the science of the heart, tuned across time. Through both and always, I love you more than time itself.*

In gratitude and with love,

Andy Lehrer, Daddy.

PS- It is now 12:53 pm 5/5/05, and these thoughts could not be more true. It is a journey just starting, and we all have much to learn and to live. I love you Gema, Sophia, and Gëanna, now and always.

Shiftwork Stress Resistance, Health & Performance:
A Predictive, Integrative Model

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Supervisor: Charles J Holahan

Integrating stress and coping research with shiftwork optimization theory and practice, the present study aims to inform understanding and application of shiftwork stress resistance properties to improve organizational health, safety, and operational performance. The design utilized established and contemporaneous survey instruments with 603 employees at baseline and at one-year follow-up, as well as objective OSHA-related data at two-year follow-up. Analyses included descriptive statistics, correlations, principal components analyses, ANCOVA, multiple linear regression, and LISREL integrative structural equation models. A theoretical model of shiftwork stress resistance is strongly supported, accounting for 78.3% of the variance in adjustment in a direct model and explaining 72.8% of the variance in adjustment in a mediational model operating both directly and indirectly through coping and in which demand, control, and support constructs all work in unique ways. From an applied perspective, a scheduling intervention utilizing data-driven, employee selected work schedules demonstrates that schedule demand, shiftwork locus of control, and spouse/partner support each significantly relate to adjustment in expected ways among those employees who report increased alertness, even after controlling for adjustment at baseline. Furthermore, control and support operate interactively in predicting adjustment, with higher levels of internal control buffering the relationship between support and adjustment, particularly in the context of low support. As well, schedule preference significantly relates to adjustment both directly and more strongly through schedule demand. Objective OSHA-related safety data at follow-up demonstrates significant improvements in both safety incidence and severity rates. Moreover, the study broadens and refines theoretical conceptualizations in two important ways. First, auxiliary coping is supported as a flexible coping response that significantly and positively relates to adjustment. Second, an expanded demand-control-support conceptualization of stress is strengthened by integrating spouse/partner support, which as predicted relates to both auxiliary coping and adjustment. Findings refine our understanding of shiftwork stress resistance and stress & coping processes

in general. In so doing, results suggest clinical implications for improving adjustment in applied contexts such as the industrial workplace and other 24/7 settings, where individuals and organizations face ongoing challenges in trying to manage biopsychosocial work requirements while optimizing health, safety, and operational performance over time.

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Overview

Why select shiftwork as a setting to model stress and coping processes, and how can such efforts inform subsequent health and performance optimization? More specifically, how does the chemistry of night illuminate properties of stress resistance, and why are such insights important? The answers may be embedded among evolving changes to the organization of time, work, and rest. Indeed, twentieth century industrialization has provided a unique opportunity to ask new questions concerning the nature of stress and coping through the introduction of shiftwork as a staple of modern day society. Accompanying this transition in the structural cadence of the workplace are fundamental challenges requiring both inquiry and innovation to optimize the health and performance of employees, their families, and the companies and communities they work, live, and shift in.

Integrating stress and coping research with shiftwork optimization theory and practice, the present study aims to inform conceptual understanding and application of shiftwork stress resistance properties to improve organizational health, safety, and operational performance. Given that shiftwork is increasingly widespread in industry and services (National Sleep Foundation, 2002; Kolgi, 1995), and approximately 20% of full time U.S. employees work irregular hours (Reese, 1996), the clinical implications of refining our understanding of coping with shiftwork stress are exciting. Maladaptive response patterns may be moderated through a better understanding of the nature of coping and its malleability in response to moderating effects of support and control. Moreover, findings may encourage proactive interventions aimed at facilitating both adaptive lifestyle changes and improvements in operational performance through the introduction and optimization of biopsychosocial work environments.

Shiftworkers – who routinely work irregular or long hours outside the traditional 9-to-5 workday – are at times viewed as individuals who can confront obstacles with wit, determination, and skill (Wedderburn, 2000, 1995). More generally, they are at times seen as more "hardy" (Kobasa, et al., 1982) and are labeled male "supermen" (Wedderburn, 1979) and female "sturdy survivors" (Wedderburn & Robson, 1990). Despite such optimistic comparisons, shiftworkers predictably manifest a greater degree of physical, psychological, social, and domestic disturbances than do their nonshiftworking counterparts (Costa, 1999; Barton et al., 1995). Shiftworkers are at greater risk for lapses in attention that can result in personal injury and poorer task performance (Helmreich & Davies, 2004; Lehrer, 2002; Filor, 1998; Hill, 1998; Folkard and Monk, 1985; Scott, 1990; Smith and Folkard, 1994). Thus, efforts towards better understanding the roles of demand, control, and support in predicting stress and performance can benefit employees and corporations.

Shiftwork can be operationalized as a stressor that imposes significant demand on finite individual resources. Given the severity, as well as both the acute (Thomas et al., 1998; Costa, et al., 1995; McCarthy, 1997) and chronic (Spurgeon, 2003; Reid, 1997; Shapiro, 1997; O'Rourke, 1998; Waterhouse et al., 1992) nature of shiftwork stress, shiftworkers represent an important population in which to study stress and coping processes. Moreover, although the demand-control model (Karasek, 1979) has enjoyed theoretical success in suggesting that different combinations of job demand and decision latitude allow a parsing of vocations along four dimensions (high strain, low strain, active, and passive jobs), little in the way of practical application has reached the factory floor.

More specifically, by integrating demand, control, and support in an intervention, the study proposes to broaden Karasek's demand-control model to reflect current advances in theory, methodology, and application. The present study also proposes to enrich our understanding of environmental and individual difference effects as they relate to shiftwork stress, and to explore the utility of scheduling and training interventions as tools to manage shiftwork-related deficits as measured by psychological and physical health, safety, and operational performance. As well, the present study proposes to further refine coping taxonomy to more specifically predict and quantify changes in adjustment and performance.

To provide a foundation for the conceptual underpinnings of the present study, a review of work place stress is presented in Chapter 1, followed more broadly by a review of the stress and coping literature. In Chapter 2, specific applications to shiftwork are presented, including a discussion of shiftwork-related outcomes. Then, shiftwork stress moderators are discussed in Chapter 3, followed by Karasek's (1979) demand-control model and methodological challenges. Next, Chapter 4 presents the rationale for the study's integrative mediational model, including an extension of Karasek's model to integrate spouse/partner support. Following this, the specific research hypotheses are presented.

Chapter 5 then describes the method of study, including the procedures, materials, and analytic strategies exercised. Broadly, the design utilized established and contemporaneous survey instruments with 603 employees at baseline and at one-year follow-up, as well as objective OSHA-related data at two-year follow-up. Analyses included descriptive statistics, correlations, principal components analyses, ANCOVA, multiple linear regression, and LISREL integrative structural equation models.

Chapter 6 presents the results of the study, which lend substantial support to the hypotheses. A theoretical model of shiftwork stress resistance is strongly supported, accounting for 78.3% of the variance in adjustment in a direct model and explaining 72.8% of the variance in adjustment in an integrative mediational model operating both directly and indirectly through coping and in which demand, control, and support constructs all work in unique ways. From an applied perspective, a scheduling intervention utilizing data-driven, employee selected work schedules demonstrates that demand, control, and support each relate to adjustment in expected ways among those employees who report increased alertness, even after controlling for adjustment at baseline. Furthermore, control and support operate interactively in predicting adjustment, with higher levels of internal control buffering the relationship between support and adjustment, particularly for low support.

Schedule preference significantly relates to adjustment both directly and more strongly through demand. Objective OSHA-related safety data shows significant improvements in safety. Moreover, the study broadens and refines theoretical conceptualizations in two important ways. First, auxiliary coping is supported as a flexible coping tool that significantly relates to adjustment. Second, an expanded demand-control-support framework is strengthened by integrating spouse/partner support, which relates to both auxiliary coping and adjustment.

Chapter 7 then discusses the practical and theoretical implications of the investigation, including future directions for research and both organization and employee-focused applications to buffer shiftwork stress resistance and improve shiftworker adjustment. Findings refine our understanding of shiftwork stress resistance and stress & coping processes in general. In so doing, results suggest clinical implications for improving adjustment in applied contexts such as the industrial workplace and other 24/7 settings, where individuals and organizations face ongoing challenges in trying to manage biopsychosocial work requirements while optimizing health, safety, and operational performance over time.

Chapter 1: The Nature of Stress and Coping

Coping is an adaptive process heterogeneously expressed across individuals and situations. Such variability characterizes the dynamic nature of coping as a stress moderator. But what drives this fluid relationship? That is, how are coping's effects moderated in an integrative mediational model of stress management? Such questions characterize the nature of the present study, which proposes to explore how efforts at optimizing coping efficacy can attenuate the deleterious effects of one of today's most pervasive stressors – shiftwork stress.

First, to establish a basis for the theoretical framework of the present study, a review of work place stress is now presented, highlighting its disruptive nature. Following this, the chapter explores a broader review of the stress and coping literature to emphasize important conceptual issues while providing a historical perspective. Finally, the chapter will critically evaluate the prior literature.

WORKPLACE STRESS

Stress has become the invisible epidemic of modern times. Health care professionals report that as many as 90 percent of patients complain of stress-related symptoms and disorders (Gibson, 1993). Moreover, stress-related disability claims have more than doubled during the past decade. Affecting more than just work productivity, the impact of stress on the individual is substantial, resulting in decreased physical and psychological health (Wedderburn, 1995; National Institue for Occupational Safety & Health, 1997). In fact, Hodgson et al. (1993) suggested that work-related stress and depression were together one of the top two challenges to health among UK employees, the other factor being musculoskeletal disorders (Cox and Griffiths, 1995).

Consequently, the area of work-related stress is rapidly assuming legitimate inclusion on both organizational and national agendas, and guidance is arising from governmental bodies (Kompier et al., 1995; Hubinger et al., 1997). Many major international agencies, such as the International Labour Office (Levi, 1984) and the World Health Organization (Cox and Cox, 1993) are addressing issues surrounding workplace stress.

This is important, because as noted by Caplan et al. (1980), various sources of occupational stress have been linked to impaired effects on employee mental and physical health. Greene and Nowack (1995) further noted that various organizational stressors have been consistently shown to relate to a number of problems with health <u>and</u> productivity, highlighting the important link between the two indices. Included among these organizational stressors are heavy job demands, role ambiguity, role conflict, poor communications between supervisors and employees, inadequate training, dysfunctional support systems, inability to reach career goals, interpersonal conflict, lack of supervisory feedback, and lack of control over decision-making (Taylor, 1990; LaCroix and Haynes, 1984, 1987; Rabkin and Struening, 1976; Beehr and Newman, 1978; Frew and Brunning, 1987; Karasek et al., 1981).

Among Air Traffic Controllers (ATCs), for example, numerous studies have found that primary sources of work stress are associated with both operative (i.e., feelings of loss of control, traffic peaks, time pressure) and organizational aspects (i.e., shiftwork, human relations, working conditions), (Crump, 1979; Farmer, 1990). Shiftwork in particular can be a crucial factor regarding both performance and adjustment, since optimal mental functioning is required throughout the shift (Luna, 1997), regardless of either the hour or workload.

Efforts to manage stress through coping behaviors play a significant role in determining the level of impairment suffered by those encountering stressful situations (Holroyd and Lazarus, 1982; Menaghan, 1983; Pearlin and Schooler, 1978; Schonfeld, 1990). Consequently, coping behavior conceptualized as efforts to attenuate or tolerate the demands created by a stressor is an important conceptualization in stress research (Folkman and Lazarus, 1980).

A critical challenge, then, is to develop effective, efficient systems for assessing and attenuating stress in the workplace, and then educating organizations in applying these systems. Therefore the present study now explores the nature of stress and coping in an effort to increase theoretical and practical understanding of stress processes in general.

HISTORICAL BACKGROUND ON STRESS AND COPING RESEARCH

The stress and coping process may be better understood by looking at its theoretical antecedents. Traditionally, psychology has focused much of its attention on pathological processes, thereby understanding vulnerabilities and illness better than adaptive strengths and health. Thus, psychologists are better prepared to treat disorder than to promote well-being and personal growth (see Antonovsky, 1987; Seeman, 1989). Interestingly, a key factor among postulated influences on mental and physical illness has been the concept of stress (Hobfol, 1986, 1988; Kaplan, 1983; Lazarus and Folkman, 1984, Milgram, 1986).

Walter Cannon (1932) adopted the term stress from the field of physics, espousing the view that humans are in some ways analogous to physical objects such as metals that resist moderate outside forces, but that lose their resiliency at some point of greater pressure (Hobfol, 1989). Cannon explored the effects of cold, lack of oxygen, and other environmental stressors on organisms. He concluded that while initial or low level stressors could be withstood, biological systems tend to break down under conditions of prolonged or severe stressors.

Cannon's emphasis on stress as response was advanced by Hans Selye (1950, 1951 - 1956), who depicted stress as "an orchestrated defense operated by physiological systems designed to protect the body from environmental challenge to bodily processes." Seyle's General Adaptation

Syndrome proposed a common reaction to outside stressors following a sequence of alerting response, resistance response, and exhaustion. This was a profoundly influential conceptualization, and assumed that all change, whether positive or negative, involves adaptive risks that are predictably related to pathological outcomes.

A second conceptualization, based on the same guiding assumption, is the <u>Social Readjustment Rating Scale</u> (Holmes and Rahe, 1967). The scale uses weighted life change units to measure the amount of life change an individual experiences during a given interval of time. Both models have shaped the understanding of scientist and layperson alike in approaching the phenomenon of stress: A multitude of subsequent findings with diverse population groups has shown that life change (particularly negative change) is associated with stress reactions that involve anxiety and depression as well as psychosomatic symptoms (Dohrenwend and Dohrenwend, 1981). Thus early stress research presumed a straightforward link between life change and dysfunction (Rahe and Arthur, 1987), and can therefore be appropriately labeled *stress-illness* research.

Changes in Modern Conceptualizations

Early <u>stress-illness</u> research overlooked individual variability in response to a stressor (Rahe and Arthur, 1987), focusing on illness rather than health. <u>Stress resistance</u> research, born in the early 1970's, began to examine personal and environmental resources and <u>adaptive</u> coping strategies that can help individuals to effectively manage stressful circumstances and to remain healthy when stressors occur (Coyne and Downey, 1991; Kessler, Price, and Wortman, 1985).

This transformation in perspective emerged in part due to several key observations linked to the results of earlier stress-illness research. For example, despite the consistency of stressor effects, the amount of variance predicted in distress is typically less than ten percent (Cohen and Edwards, 1989). Moreover, individuals show highly variable reactions to stressors; many persons remain healthy despite being exposed to stressful circumstances and some people mature more rapidly after effectively managing stressful events (Stewart, Sokol, Healy, and Chester, 1986).

At first, researchers assumed that these findings reflected measurement error, but eventually understood them as important findings in their own right (Holahan and Moos, 1994). The comparatively poor empirical predictions of early stressor-illness studies led investigators to focus increasingly on the moderating role of adaptive resources and coping strategies.

Thus stress research has evolved from placing an initial emphasis on people's deficits and vulnerabilities to placing increasing emphasis on individual's "adaptive strengths and capacity for resilience and constructive action in the face of challenge" (Holahan and Moos, 1994). Antonovsky (1979; 1987) offered a neologism, *salutogenesis*, to characterize this emergent study of health. He underscored the importance of generalized resistance resources in facing a wide array of stressors. Stress resistance researchers therefore currently construe the individual as active and resourceful. Investigators further assume that the human stress response is inherently complex and reflects a dynamic interplay among stressors, personal and social resources, and coping efforts (Kessler, Price, and Wortman, 1985; Lazarus and Folkman, 1984).

Summary

Stress researchers have shifted their conceptualization of stress as an invariant response to a given stimulus. Instead, debate has progressively cultivated the more recent view of stress as a dynamic process moderated by personal and social resources. The chapter now turns to a general overview of coping responses to further develop a conceptual link for exploring the effects of stress variables as they relate to health and illness outcomes.

THE NATURE OF COPING

The conceptualization of coping processes is a central aspect of contemporary theories of stress. Coping has been broadly defined as "things that people do to avoid being harmed by life-strains" (Pearlin and Schooler, 1978, p.2) and "any efforts at stress management" (Cohen and Lazarus, 1979, p. 220). Fleishman (1984) defines coping as cognitive or behavioral responses "to reduce or eliminate psychological distress or stressful conditions" (p. 229). More generally, coping is viewed as a stabilizing factor that can help individuals maintain psychosocial adaptation during stressful periods (Lazarus and Folkman, 1984; Moos and Schaefer, 1993).

Major Categories of Coping

Broadly, more time has been devoted to studying the relationships between coping and distress than to relations between coping and situational specificity (Vitaliano, Maiuro, Russo, Katon, DeWolfe, and Hall, 1990). In fact, many researchers have supported the conceptual model of stress and coping developed by Lazarus and his colleagues (Lazarus, 1966; Lazarus and Folkman, 1984). They posit that stress consists of two appraisal processes (appraisal of threat, challenge, or loss and appraisal of response method) in addition to the execution of coping responses.

Problem Based vs. Emotion Based Coping

Broadly, one can distinguish among coping efforts by dividing them into problem-focused coping — efforts to remove the threatening event or diminish its impact, and emotion-focused coping — attempts to reduce the negative feelings that arise in response to the threat (Lazarus and Folkman, 1984). Moreover, one approach may modify the efficacy of the other; thus, the two responses can co-occur.

Pearlin and Schooler (1978) distinguished between efforts to change the situation and efforts to control distress, as well as responses that change the cognitive appraisal of the stress. For example, among individuals treated for depression, more use of problem solving and less dependence on emotional discharge were related to better outcome at follow-up one year later (Billings and Moos, 1985). Additionally, depressed patients who depended less on emotional discharge at a one-year treatment follow-up reported less depression and fewer physical symptoms four years post-treatment (Swindle, Cronkite, and Moos, 1989).

Approach vs. Avoidance Coping

Although coping responses may be classified in many ways (Moos and Schaefer, 1993), at a general level many approaches distinguish between strategies oriented toward approaching and confronting the problem and strategies oriented toward avoiding dealing directly with the problem (Roth and Cohen, 1986). Broadly classified, more or greater proportions of approach coping are associated with better psychological outcomes, and more or greater proportions of avoidance coping with poorer outcomes (Compas, Malcarne, and Fondacaro, 1988; Holahan and Moos, 1990, 1991; Vitaliano, Maiuro, and Russo, 1987).

For example, active coping strategies utilizing optimistic comparisons and negotiation have been linked to fewer future role problems and to reductions in concurrent distress (Menaghan, 1982). Moreover, the proportion of problem-focused approach coping relative to total coping efforts has been associated with reduced depression (Mitchell, Cronkite, and Moos, 1983). As well, Gaston and her colleagues (1988) noted that depressed patients who depend more heavily on avoidance coping have more difficulty forming a positive psychotherapeutic relationship. Furthermore, avoidance coping, such as withdrawal and denial, is generally correlated with psychological distress — especially when adjustment is assessed beyond the initial crisis period (Holmes and Stevenson, 1990; Suls and Fletcher, 1985).

Interestingly, since emotionally focused coping frequently involves self-blame and avoidant-oriented fantasy, it often correlates with higher levels of depression (Endler and Parker, 1990). Older adults who relied on ineffective escapism, such as avoidant, reckless, and helpless coping behaviors, experienced greater current and future emotional distress (Rohde, Lewinsohn, Tilson, and Seeley, 1990).

Similarly, the use of avoidance coping, such as self-blame and wishful thinking, predicted future psychological disturbance among elderly persons dealing with negative life events (Smith, Patterson, and Grant, 1990). Menaghan (1982) has suggested that attempts to control unpleasant feelings by withdrawal and resignation may increase distress and thus amplify future problems.

In studies of the health consequences of selected coping strategies, Billings and Moos (1981) have shown a positive association between psychological distress and avoidance coping. Avoidance coping is negatively related (Mayou and Bryant, 1987) and approach coping positively related (Scheier, et al., 1989) to subsequent quality of life among recovering cardiac surgery patients. Holahan and Moos (1985) showed that people who adapted to stress with little physical or psychological strain were less likely to rely on avoidance coping than were individuals who showed psychological dysfunction under stress (see also Holahan and Moos, 1986).

Conversely, lawyers who relied more on avoidance coping strategies in response to life stressors showed more symptoms of physical and psychological strain (Kobasa, 1982). As well, Moos, Finney, and Cronkite (1990) found in a longitudinal study that cognitive approach coping predicted less alcohol consumption and depression eight years later, while greater avoidance coping predicted more depression eight years later. Thus avoidance coping is generally associated with detrimental effects when used to deal with ill health and addiction.

Cognitive vs. Behavioral Coping

Billings and Moos (1981) proposed a more narrowly specified typology consisting of active-cognitive strategies (efforts to manage the appraisal of the event's stressfulness), active-behavioral strategies (overt behavioral attempts to deal directly with the problem), as well as cognitive or behavioral avoidance strategies (mental distractions to avoid facing the problem or indirectly reducing tension through behaviors such as increased eating or smoking). Using active-cognitive coping strategies such as seeking information and problem-solving, for example, can mitigate the potentially adverse influence of both negative life change and enduring role stressors on psychological functioning (Billing and Moos, 1981; Pearlin and Schooler, 1978).

Summary

The literature suggests that there are several ways to classify efforts at coping, including problem based versus emotion based, approach versus avoidance, and cognitive versus behavioral strategies. Generally, people who rely more on approach coping tend to adapt better to life stressors and experience fewer psychological and physical symptoms than do people who rely more on avoidance coping. With these findings as a conceptual foundation, the chapter now explores stress moderators as factors contributing to the selection and intensity of one's coping response. Later, in chapter 3, the paper will undertake a more detailed exploration of moderators as they relate specifically to coping with shiftwork stress.

STRESS MODERATORS

Research on stress and coping has emphasized coping determinants involving stable, structural properties both of the person and of the environment (Folkman and Lazarus, 1985). Studies of coping, for example, have in the past focused largely on coping traits (e.g., Goldstein, 1973; Krohne and Rogner, 1982; Moos, 1974). Accordingly, a large body of research has investigated the role of personal and social resources in stress resistance (Thoits, 1985; Cohen and McKay, 1984; Cohen and Edwards, 1989).

Personal Resources

Personal resources include relatively stable cognitive and personality characteristics that mold the appraisal and coping process. Moreover, a variety of dispositional factors relating to personal control and self-confidence may buffer an individual from the negative effects of stressors and appear especially important as coping resources. Such factors include hardiness (Kobasa, 1982; Kobasa, Maddi, and Kahn, 1982), self-efficacy (Bandura, 1982), learned resourcefulness (Rosenbaum and Ben-Ari, 1985), and a sense of coherence (Antonovsky, 1979, 1987). A calm, easygoing disposition, as opposed to one characterized by irritability and impatience, may also provide stress resistance (Rhodewalt, Hays, Chemers, and Wysocki, 1984; Suls, Gastorf, and Witenberg, 1979).

Locus of Control

Interestingly, the extent to which a particular stress state affects an individual's performance depends on the degree of control one believes to exert over the environment (Hockey, 1986). Broadly, control has been conceptualized as a dispositional coping resource, and much research has focused on an individual's generalized beliefs about the degree of control one can exert over outcomes in daily life (Jackson, 1989).

The personality characteristic described as locus of control (LOC) has been investigated in a number of situations including occupational settings. The construct, developed by Rotter (1966), refers to generalized expectations concerning the origin of control over outcomes. More specifically, Rotter distinguished between internal and external sources of control, with internals (those individuals having an internal locus of control) tending to believe that reinforcements are contingent upon their own attributes or behaviors. Furthermore, internals are more likely to engage in active, problem-solving coping processes than are externals (Anderson, 1977).

In contrast, externals (those individuals with an external locus of control) were more likely to perceive outcomes as contingent upon forces beyond their influence. The literature further suggests that externals are less likely to engage in coping through active problem solving and are more likely to engage in emotion focused strategies such as avoidance (Strickland, 1978; Fleishman, 1984; Parkes, 1984; Carver et al., 1989; Terry, 1991).

In a thorough review of the effects of locus of control in organizational settings, Spector (1982) presented evidence that internals are more likely to attempt control over a variety of job aspects, including work scheduling, interpersonal relationships, task accomplishment, and goal setting. With respect to work performance, internals are predicted to perform better because they have higher expectancies that their efforts will produce desired results, and they tend to seek more relevant information and perform more effectively than do externals (Spector, 1982). Thus internal-external locus of control (I-E) is a personality factor involved in the appraisal of event controllability.

Accordingly, several studies have examined the effect of locus of control on event controllability and outcomes. In a review of studies relating LOC to health, Strickland (1978) concluded that internals tended to be associated with more positive health outcomes. Similarly, Kirscht (1972) suggested that beliefs in controllability correlate with beliefs that health problems can be overcome. More specifically, the findings proposed that internals are more likely to enlist behaviors aimed at preventing or reducing problems, as well as show more interest in obtaining information about protective behaviors.

Moreover, intensive care patients classified as internal using Rotter's Internal-External Locus of Control Scale (Rotter, 1966) were rated by the professional staff as being less depressed and more cooperative during their stay in an Intensive Care Unit than were externals (Cromwell, Butterfield, Brayfield, and Curry, 1977). Further, internals had lower peak temperatures during intensive care and left both the unit and the hospital earlier than did externals.

Further evidence suggesting the significant role of beliefs about control and mastery in predicting coping responses to stressors comes from studies of stress experienced in medical education (Kilpatrick, Dubin, and Marcotte, 1974), in commuting to work (Novaco, Stokols, Campbell, and Stokols, 1979), in adapting to Marine Corps training (Cook, Novaco, and Sarason, 1980), and in caring for sick children (Hobfol and Lerman, 1988).

Locus of control (scored in a positive direction) was also found to be negatively correlated with the intensity of post-traumatic stress disorder among Israeli soldiers at both two and three years after the 1982 Lebanon war (Solomon, Mikulincer, and Avitzur, 1988). Interestingly, Spector (1982) suggested that high internals may be safer because they tend to exert greater effort and are more careful in performing tasks.

Social Resources

Social resources can provide emotional support that promotes greater feelings of self-esteem and belonging. Such support is useful in assessing threat and planning coping strategies (Cohen and McKay, 1984), and in buffering the effects of stress (Dalbokova et al., 1995). Moreover, social support is correlated with mental and physical health, with quicker recovery from illness, and with the likelihood of remaining healthy under stress (see Cohen and Wills, 1985; House, Landis, and Umberson, 1988; Wallston, Alagna, DeVellis, and DeVellis, 1983).

More specifically, Cobb (1976) conceptualized a three-dimensional model of support including 1) information that guides the individual to believe that he or she is cared for (emotional support), 2) information that the individual is esteemed (esteem support), and 3) information that the person belongs to a network of mutual obligation and communication (network support).

Summary

Research on stress resistance embodies a fundamental change in the conceptualization of the stress process. Whereas traditional stress-illness research has portrayed stressors as resulting in dysfunction, stress resistance research focuses on one's capacity to stay healthy during stressful periods. Furthermore, coping has been shown to be a dynamic construct that has adaptive value for the individual, and two key moderators that influence coping responses are locus of control and support.

Chapter 2: Applications in Terms of Shiftwork

The paper will now review the literature on work-related stressors as they relate specifically to shiftwork applications. First, the chapter will describe the extent of shiftwork stress in terms of prevalence, costs, and regulatory efforts. The chapter will then review circadian rhythms and discuss the rationale for categorizing shiftwork as a significant stressor affecting health, safety, and well-being. Next, building on the historical perspective provided in Chapter 1, outcomes relating to shiftwork stress will be discussed.

SIGNIFICANCE OF SHIFTWORK STRESS

The chapter now considers the problematic nature of shiftwork. This section first discusses the increasing prevalence of shiftwork, and then presents the costs associated with working around the clock. Finally, the section concludes with a report on regulatory efforts aimed at mitigating adverse consequences of shiftwork stress.

How Much Today?

Increasingly, shiftwork is widespread in industry and services (International Labour Office, 1986, 1990; Kogi, 1995). In fact, about 10% of all companies in the United States operate 24 hours a day (Presser, 1995), employing about 20% of the workforce. As well, Barton et al. (1995) estimate that 20-25% of employees in the manufacturing sector, and an ever-increasing proportion of those employed in service industries are working on some type of shift system.

Moreover, approximately 20% of full time American employees work nonstandard hours (Presser, 1995, Reese, 1996), and this number is likely to increase as we continue to pursue a twenty-four-hour-society (Moore-Ede, 1992). By the year 2005, even without an expected percentage increase, there will be approximately 30 million shiftworkers in the United States alone (Moskowitz, 1996). To provide some perspective for the magnitude of this number, consider that "Rock Around the Clock" (Myers, 1953 as performed by Bill Haley and His Comets, 1954) is the third best selling recorded single to date, but with 25 million copies would still fall short of providing each shiftworker their own personal forty five as they prepared to address the cadence of their own around-the-clock rhythms.

Costs

The cost of shiftwork's stressful lifestyle, in terms of increased physical and mental health care, industrial accidents, and reduced productivity, has been estimated in excess of $77 billion per year in the U.S. alone (Institute for Circadian Physiology, 1990). Physically, shiftworkers experience a greater prevalence of digestive problems (Waterhouse et al., 1992) and cardiovascular disease (Knutsson, 1989). Psychologically, an association exists between shiftwork and depression (Barton, 1995; Bohle and Tilley, 1989; Scott, Monk, & Brink, 1997) and shiftwork and anxiety (Costa, 1981).

Akerstedt (1990) concluded that the major safety-related effects of shiftwork impact sleep, alertness, and performance. Increasingly, sleepiness and its implications for health and safety have also been recognized as a critical public health issue (Mitler et al., 1988; Akerstedt, 1995; Lehrer, 1998, 2003). In fact, impaired and truncated sleep are among the most frequent problems of shiftwork (Spelten et al., 1995). Because sleepiness disturbs the ability of nighttime workers to safely and effectively perform their duties, it is not surprising that sleepiness is considered a major cause of industrial and transportation accidents (Mackie and Miller, 1991; Filor, 1998).

Even considering only economic realities, organizations lose more than productivity when industrial accidents occur. Increasingly, companies are subject to litigation both from within and outside the corporation. For example, the latter was demonstrated in Hale v London Underground (Current Law, March 1994), during which entitlement of a rescuer to recover damages for psychological injury was accepted.

Regulatory Efforts

Until recently, stress research has been relatively unsuccessful in bringing about national policy changes concerning occupational health and safety. One exception has been the Nordic countries, where meaningful progress has been made (Cox and Griffiths, 1995). More recently, however, work-related stress is increasingly appearing on national agendas and quickly becoming an important part of policy decisions. For example, many international agencies such as the World Health Organization (Cox and Cox, 1993) and the International Labour Office (Levi, 1984) now address the issue of work-related stress.

Summary

The prevalence of shiftwork is increasing. As well, there are considerable costs associated with physical and psychological health, safety, productivity, and liability relating to shiftworker stress. Regulatory agencies have recently made progress in bringing the issues of work-related stress to national policy agendas, and in so doing, are attempting to mitigate the consequences of shiftwork stress on health, safety, and performance. Having highlighted the pervasiveness of adverse outcomes relating to shiftworker stress, the chapter now turns to a discussion of the biological clock to provide an explanation for why such outcomes exist.

The Biological Clock

Numerous biological activities rise and fall in rhythmic patterns in humans as well as in other animals, plants, and even in single-celled organisms (Moore-Ede, 1993; Shaw & Brody, 2000). In fact, the endogenous ability to keep time seems to be a genetically coded characteristic of life. Such biological rhythms, repeating approximately every 24 hours, are termed circadian rhythms.

Location and Function

These rhythms are generated by an internal pacemaker, or clock, located in the suprachiasmatic nucleus (SCN) of the human brain, above the optic chiasm. This internal clock consists of thousands of small hypothalamic nerve cells (Moore-Ede, 1982) that function, among other things, to drive levels of alertness and fatigue.

Humans display circadian rhythms for a variety of physiological functions including body temperature, hormone secretion, organ system functioning, the immune system, sleep, and wakefulness (Saunders, 1977; Moore-Ede, et al., 1982; Costa, 1999). Furthermore, many psychological processes and mental functions affecting human performance are also influenced by circadian fluctuations. These include memory, reaction time, manual dexterity, and subjective feelings of alertness. There also exists an increasing interest in the role of the circadian timing system in the development and maintenance of mood disorders (U.S. Office of Technology Assessment, 1991).

For example, it is hypothesized that circadian rhythms are advanced, delayed, or evidence an attenuated amplitude during seasonal affective disorder (SAD). Moreover, people suffering from nonseasonal depression may show altered circadian profiles concerning physiological functions. As well, the moods of nonseasonally depressed individuals typically fluctuate daily, with improvements as the day progresses.

Entrainment and Implications for Shiftwork

Although circadian rhythms persist even in the absence of environmental cues, the pattern of light and dark cycles functions efficaciously as a synchronizing, or entraining agent for underlying circadian rhythms. Thus light and dark cycles help to reset the internal clock each day. Other less influential entraining agents, or "zeitgebers", include exercise, social activity, and the timing of meals. Interestingly, although humans typically live in a twenty-four-hour world, the natural tendency of the biological clock may be to cycle at periods of approximately twenty five to twenty five and a half hours (Moore-Ede, 1982, 1993), although recent research suggests that at least certain aspects of the clock's timing system may in fact cycle in near 24-hr intervals (Czeisler, 1999), underscoring the importance of continued research to expand and refine understanding in the relatively young field of chronobiology.

One phenomenon that is well documented is an entraining agent's ability to phase shift, or reset, the biological clock in a direction dependent upon when the agent is applied (Moore-Ede, 1982). A resetting of the clock produces a shift in the beginning and end of the cycle, although the length and progression of change within the cycle remains intact. A circadian rhythm's flexibility in adjusting to various environmental cues determines the level to which the timing of a particular function under rhythmic control is altered. That is, when internally generated rhythms are disrupted by changes in environmental cues, as in jet lag and shiftwork, human function can be compromised until a resynchronization occurs (Office of Technology Assessment, 1991).

Such compromised function is frequently accompanied by disturbed sleep, decrements in performance, and a general feeling of malaise. This is not surprising, since the rhythmicity of the endogenous circadian timing system regulates our normal sleep-wake cycle. Its disruption adversely affects the day sleep of night workers and results in greater difficulty falling and staying asleep. Duration and quality of sleep are also negatively impacted on a morning shift (e.g.., 7 a.m. - 3 p.m.), since the worker is required to awaken at a time when the circadian rhythm is near its lowest phase (Akerstedt, 1985; Folkard and Barton, 1993).

Consequently, there are direct implications for the ability of a worker to readjust following rapid changes in work/rest schedules, or to cope with patterns of work and rest that are out of sync with one's endogenous circadian cycle. Shiftworkers therefore are particularly vulnerable to circadian-related physiological and psychological stressors. Yet, only in the past two decades have scientists broadly begun to reach consensus on some of the deleterious health and behavioral effects of shiftwork. This is not surprising, since comprehensive understanding of the physiological mechanisms underlying the human circadian timing system have also only been elucidated during the last two decades.

Currently, practical applications based on the science of biological timing systems are emerging for both shiftworkers and other populations. For example, scientists are now exploring the implications of circadian rhythms for the timing of surgery and drug administration, given that circadian effects may suggest optimal timing procedures to enhance efficacy. As knowledge of timing systems and human capabilities advance, so too should our understanding of coping with shiftwork as a stressor.

Summary

Basic research has delineated many physiological and cognitive functions that fluctuate predictably under traditional environmental conditions involving working during the day and sleeping at night. In this way, circadian rhythms provide a temporal framework for a number of important physiological and behavioral outcomes. However, individuals working nontraditional hours are at increased risk of placing endogenous biological rhythms out of sync with environmental demands (Folkard, 1996). Consequently, this imbalance can create physiological and psychological stressors that adversely affect overall health and well-being.

DSM-IV-TR Classification

The American Psychiatric Association recognizes such potential for manifesting adverse symptomatology when endogenous circadian rhythms are discordant with exogenous environmental demands (Diagnostic and Statistical Manual of Mental Disorders, 4th ed., text revision, 2000). Moreover, this revised manual supports the critical role of the circadian timing system and further refines preceding DSM-IV (1994) criteria, which had replaced the earlier diagnosis of Sleep-Wake Schedule Disorder (DSM-III-R) with the current diagnosis (307.45) termed Circadian Rhythm Sleep Disorder (DSM-IV-TR, 2000).

Diagnostic Criteria

The diagnostic features are as follows:

A. A persistent or recurring pattern of sleep disruption leading to excessive sleepiness or insomnia that is due to a mismatch between the sleep-wake schedule required by a person's environment and his or her circadian sleep-wake pattern.

B. The sleep disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.

C. The disturbance does not occur exclusively during the course of another Sleep Disorder or other mental disorder.

D. The disturbance is not due to the direct physiological effects of a substance (e.g., a drug of abuse, a medication) or a general medical condition.

DSM-IV-TR (2000) further divides the diagnosis among four subtypes: delayed sleep phase type, jet lag type, shift work type, and unspecified type. Of the four diagnostic subtypes, both the jet lag type and the shift work type are characterized by normal endogenous cycles compromised by abnormal exogenous patterns. Interestingly, the term "industrial jet lag" is often used to characterize symptoms experienced by shiftworkers, who, like travelers rapidly changing time zones, fulfill environmental requirements at the expense of biopsychosocial demands. The basic features relating to shiftwork (DSM-IV-TR, 2000) are now reproduced:

> **Shift Work Type:** insomnia during the major sleep period or excessive sleepiness during the major awake period associated with night shift work or frequently changing shift work

Summary

Thus shiftwork has been conceptualized as a significant stressor by the industrial, regulatory, and academic communities. The chapter now turns to a more detailed review of shiftwork-related effects on health, safety, and performance, followed by a discussion of a number of relevant variables moderating the effects of shiftwork stress.

SHIFTWORK AS A STRESSOR

Recently, Theorell and Karasek (1996) suggested that at a general level shiftwork has progressed from an arena of core conceptual debate to a scientifically established and significant job stressor. More specifically, shiftwork in general and nightwork in particular are sources of physical and psychological stress, given that individuals have to work against endogenous programmed rhythms of activity, eating, and sleeping as well as manage disruptions to family and social life (Wedderburn, 1995).

The discussion now focuses on the nature, breadth and depth of shiftwork as a stressor. Accordingly, a review of the biopsychosocial characteristics of shiftwork stress is presented, categorized according to alertness and performance effects, physiological effects, and psychosocial effects.

Alertness and Performance Effects

Broadly, an observed decrease in alertness during the night as compared to the day has been replicated across several studies (Akerstedt, 1977; Dahlgren, 1981; Monk and Embrey, 1981; Kiesswetter, 1988; Lehrer, et al., 1998). More specifically, alertness among nightshift workers is typically lower than among dayshift workers (Monk and Folkard, 1985). For example, there is a lower resistance to sleep onset during the early hours of the morning, when most nightshift workers are still on the job. Consequently, the nightshift is the most problematic for operational safety (Smith and Folkard, 1993; Lehrer, 2003). Moreover, the lowest levels of alertness and greatest sleepiness and distractibility were found at 6 a.m. on the night shift (Dalbokova et al., 1995).

Linking alertness with performance, studies have consistently demonstrated that errors in performance also evidence a circadian variation, occurring most frequently in the early hours of the morning (Folkard and Monk, 1979). Regarding errors contributing to fatalities, such mistakes were most apt to occur during skilled behavior and to occur immediately before the accident (Williamson and Feyer, 1990).

An interesting exception to the general trend of decreased alertness at night was observed in simple tasks with a high memory load, where immediate memory for information was enhanced during the night (Folkard et al., 1976). Moreover, the least errors in the Sternberg version of a memory search test with a high memory load (5 letters) occurred at 4 a.m. during the night shift, a time when alertness approaches its low point in the circadian cycle (Knauth et al., 1995).

These findings illustrate the variance seen in time-performance curves among tasks tapping different abilities. Furthermore, although decrements in alertness have also been observed during the circadian "post-lunch dip" (Bjerner and Swenson, 1953; Browne, 1949; Hildebrandt et al., 1975), Monk and Embrey (1981) found that on-the-job performance of process controllers with a high memory load was at its best during both the night-time and the post-lunch dip, adding support to Folkard's (1976) earlier laboratory findings.

But despite this latter suggestion that some memory tasks may be better performed on the night shift, it is in fact the less repetitive, reasoning intensive tasks requiring rapid, accurate responses that nightshift workers are often less prepared to perform, such as when an alarm sounds from the console of an electrical utility plant, or when a machine requires rapid repair in a similarly time-sensitive manufacturing environment. As well, low workload can result in a lack of stimulation that further increases the normal attenuation in mental and physical efficiency during nighttime hours. Such a circadian dip in performance can be especially critical during emergency situations (Costa, 1991; Folkard, 1990).

Moreover, stress states can also emerge as transient negative states induced by job task demands and the work environment (Dalbokova et al., 1995), such as exposure to prolonged and monotonous work or sleep deprivation (Hockey and Hamilton, 1983). Nuclear operators, for example, experience a low arousal pattern of stress states, including distractibility and irritability (Dalbokova et al., 1995). When these and other control room operators are asked to sustain continuous attention in the absence of relevant task information, such conditions promote a subjective state of boredom, characterized by symptoms of reduced activity of higher level functions together with a feeling of lethargy and diminished alertness.

The inability to adequately maintain alertness during these and other safety critical shiftworking tasks can significantly affect the safety of the employee, coworkers, and the population at large. In fact, laboratory research on vigilance under watch keeping tasks has demonstrated a reduction in signal detection over time (Davies et al., 1983). As well, increasing irritability may occur as a result of the monotonous work environment (Grandjean, 1987). Interestingly, a considerable increase has also been observed among nightshift workers in the percentage who perceived difficulty transitioning from routine monitoring to rapid responding to an abnormal situation (Gadbois et al. 1987; Lehrer & Mitchell, 2002) .

Such nighttime barriers to alertness were noted in a report to the International Atomic Energy Agency (Grauf, 1988), whose findings suggest that, "the inability to perform work with equal ease over 24 h is in conflict with the need for reliable work at all times in nuclear power facilities." A similar concern was reflected in 1987 when the US Nuclear Regulatory Commission shut down the Peach Bottom nuclear power plant after finding that control room operators "periodically slept or had been inattentive to duties," particularly during the nightshift (US Congress, Offices of Technology Assessment, 1991). Furthermore, it is significant that human error during the night shift has been associated with system failure in the large industrial accidents of our time, such as Three Mile Island and Chernobyl (Ehret, 1980; Folkard, 1990).

Fear of Committing Errors

Moreover, Gadbois et al. (1987) demonstrated that there exists an awareness among shiftworkers of attenuated functional competence during the nightshift and suggests that there may be an association between circadian variations in performance and stress related to the fear of committing errors, particularly on the night shift. In fact, Smith and Folkard (1993) found that the nightshift was reported to be the most problematic in terms of poorer perceived health and greater stress.

Anecdotally, another job involving high stress levels and clear fear of committing errors involved a work force that experienced disproportionately high incidents of stress-related symptoms. In this mining operation, shiftworkers were required to navigate steep, narrow terrain in 220 ton trucks and then deposit their load into large processing pits after backing up to the edge of a 500 foot cliff. Having experienced this procedure in relatively dry, stable weather, an appreciation was fully recognized for the shiftworkers' concern for safety, particularly during times of fatigue coupled with inclement weather.

Working Nights

In particular, working the night shift appears to be associated with several negative aspects in terms of both acute and chronic manifestations (Costa et al., 1995). Nightshift workers receive less sleep than their day or evening counterparts. Related incidents of fatigue are in turn associated with negative effects upon mood and performance, as well as an increased incidence of accidents and errors (Transportation Safety Board of Canada, 1997). The troublesome nature of working nights is not surprising, given that many studies have shown that adjustment of circadian rhythms and sleep-wake patterns to nighttime work is never complete (Colquhoun et al., 1968; Knauth et., 1978, Lehrer, 1998; Torsvall et al., 1981; Dahlegren, 1981).

Anecdotally, a common source of frustration among fixed nightshift workers relates to their faulty perception that they may in some way have something uniquely wrong with them because they can not fully adjust to working nights even after as many as 30 years (Lehrer, 2003). Often times it appears that potentially sensitive events, such as the tendency to frequently awaken during daytime sleep to urinate, is not discussed among shiftworkers. Consequently employees are often comforted to know that other nighttime workers undergo a similar physiologically driven rhythm.

Such physiological predispositions tend to disrupt daytime sleep efforts. Moreover, because waking typically occurs on the rising phase of the temperature cycle (Czeisler et al., 1980), daytime sleep after a nightshift tends to be shortened and distorted. More specifically, such truncated daytime sleep affects primarily stage 2 sleep and rapid-eye-movement (REM) sleep, and to a lesser degree, slow-wave sleep (SWS) is also affected (Tilley et al., 1982; Akerstedt, et al., 1991).

As well, psychosocial influences affect sleep quality and duration, since nightwork is typically in direct conflict with both social and domestic commitments. Furthermore, environmental conditions are important since daytime sleep is impaired by light, temperature, and noise. Thus, shiftworkers are often forced to battle biological, psychosociological, and environmental pressures when attempting to sleep during the day (Lehrer, 2000).

Instead of battling daytime sleep, some night workers attempt to adopt a daytime schedule in-between clusters of night shifts due to social and domestic pressures, but this is also problematic given both the difficulty in suddenly shifting to days and the required transition back to nights once work resumes. Unfortunately, any gains achieved in reverting to days typically make the ensuing transition to working nights again that much more stressful.

It is important to consider, therefore, that environmentally induced changes in sleep patterns not only affect the ability to initiate and maintain restful sleep, but also affect the ability to stay awake during atypical hours when one may be performing safety critical tasks. Not surprisingly, night work is associated with a reduction in performance due to both reduced day sleep and impaired arousal (Rosa et al., 1990, Tepas and Carvalhais, 1990).

More specifically, when working the night shift, and to a lesser degree when working the morning shift, workers are more likely to experience reduced sleep quality and quantity as compared to their so-called nine to five counterparts. (Akerstedt, 1985; Weitzman, 1976). Furthermore, increased accident rates among night-workers are likely a consequence of fatigue associated with disturbed day sleep (Mitler et al., 1988).

Time of Day Effects

Consistent with the earlier review on alertness and performance effects, the time of day in the work schedule appears to be a better predictor of work-related accidents than consecutive hours of service (Federal Railroad Administration, 1995). In fact, of the 48 fatigue-related U.S. Railway accidents occurring between 1989 and 1991, engineers were more than 15 times as likely to have an accident during the circadian dip in alertness at 6 a.m. as opposed to the circadian peak in alertness at 6 p.m. (Federal Railroad Administration, 1995). Cutting hours of service back from 12 to 10 hours, for example, would not have significantly diminished the number of accidents, and could perhaps have increased them since more engineers would have been required to be awake during problematic hours.

Moreover, consistent with the above studies of U.S. Railway accidents, such tasks become more arduous to perform during the early morning hours (Folkard and Monk, 1979; Monk and Folkard, 1985). Clearly, research suggests that reduced alertness and decreased performance relating to time of day effects may enhance the potential for human error (Tilley et al., 1982).

Other studies have consistently shown that vigilance tasks require substantial mental effort by the operator (Davies et al., 1983; Krueger, 1989; Warm, 1984; Arnold & Hartley, 1998). For example, long-distance driving is a task that demands periods of sustained attention, often under monotonous conditions. Therefore it is not surprising that the risk of heavy vehicular accidents has been shown to increase by time of day; that is, midnight to dawn hours are significantly over-represented in accident statistics (Hamelin, 1987; van Ouwerkerk, 1987; Lehrer, 1999; Mackie and Miller, 1978).

Although those concerned with the management of professional drivers have attempted to address alertness and fatigue issues, their efforts have largely focused on the amount of time spent on the job. Both regulatory efforts (placing maximum limits on consecutive working hours and minimum limits on resting hours) and operational efforts (providing a relief driver as part of a team or at an established changeover point) have been employed, yet neither approach adequately considers the relationship between time of day and performance.

Interestingly, drivers working shorter continuous hours became fatigued much earlier in their trips than did drivers working far longer hours. An "anticipatory" effect may exist whereby workers tend to become fatigued as they approach the end of their shift, regardless of shift duration. Anecdotally, this "winding down" effect among shiftworkers occurs across a diverse range of job classifications.

Moreover, those truck drivers working the longest hours were not necessarily more fatigued than other drivers. In fact, fewer drivers working the longest hours reported a problem with fatigue as compared to drivers working fewer consecutive hours. Instead, the pattern of work and rest, as well as time of day effects, appeared to be better indicators of fatigue levels. Whereas shorter hours appeared to only partially offset fatigue occurrence, longer hours did not facilitate fatigue occurrence linearly (Feyer and Williamson, 1995).

Of course it is possible that drivers sustaining longer continuous hours represent a self-selected group particularly able to cope with such task demands (Williamson et al., 1992) Nonetheless, it appears more likely that the strategies employed by such drivers, in concert with time of day effects, account for the observed outcomes. When rest periods were arranged to better coincide with normally occurring periods of fatigue (i.e., in the early morning hours and in the early afternoon), drivers fared better despite working longer hours (Feyer and Williamson, 1995). In fact, the combined effects of time of day and time on the job are multiplicative as opposed to additive (Moore-Ede et al., 1988).

Lighting

Lighting also affects the circadian system, and is therefore an important consideration for workers trying to manage alertness levels (Sirois & Lehrer, 1993). Lewy et al. (1980) found that bright light could suppress the nighttime secretion of melatonin, a hormone associated with patterns of sleep and wakefulness. Czeisler and Kronauer (1986) suggested that properly timed exposure to bright light and darkness could reset the timing system of the brain within 2 or 3 days. Furthermore, Phase Response Curves (PRC's) gathered in temporal isolation units indicated that early morning light produces advance and evening light produces delay of the normal circadian temperature cycle (Czeisler et al., 1989). In contrast, only a slight shift was observed when the stimulus occurred within subjective day. The phase-shifting effect of bright light may help to normalize the association between daytime sleep and body temperature rhythm in nightshift workers. Moreover, studies have demonstrated improvements of both nighttime performance and diurnal sleep quality and quantity during simulated nightshift performance under bright light (Czeisler et al., 1991; Dawson and Campbell, 1991; Eastman, 1987).

Summary

At a general level, decrements in nighttime alertness as compared to the day are well replicated across a wide range of laboratory and field studies. Lack of sufficient stimulation also promotes attenuation of alertness levels. Furthermore, fear of committing critical errors can lead to increased levels of shiftworker stress. Also, working the night shift is associated with an important range of negative health and safety outcomes. Moreover, time of day appears to be a better predictor of work-related accidents than consecutive hours of service. Finally, lighting effects can influence circadian adaptation to working nights.

Physiological Effects

When studying the effects of shiftwork over time, it is important to note that while the literature broadly supports a decrement in functioning and well-being relating to shiftwork, the precise long-term health consequences of night work are difficult to ascertain given that those workers experiencing the greatest amount of symptomatology are likely to have changed to day work, leaving behind a "survivor population" (Frese and Semmer, 1986). Such a drop-out effect may account for some lack of consistency among certain studies in the shiftwork stress literature (Barton et al., 1995; Lehrer, 1999). Broadly, however, there is consensus on the deleterious health effects of working shifts.

Gastrointestinal Effects

Costa (1993) reviewed 25 studies covering 56,741 workers and reported an increased prevalence of gastrointestinal disorders among shiftworkers as compared to dayworkers in all but one study. Waterhouse et al. (1992) has estimated that gastrointestinal disturbances in shiftworkers occur at a rate of between five and ten times that seen in dayworkers. Moreover, 30 - 50% of shiftworkers are thought to be affected. Symptoms include loss of appetite, heartburn, constipation, flatulence, stomach pains, and ulcers (Barton et al., 1995).

The mechanism through which these disorders manifest themselves is not entirely clear; however, an interaction between two primary factors seems plausible (Barton et al., 1995). First, the <u>timing</u> of shiftworkers' meals is disturbed, with many meals being missed altogether. Secondly, Cervinka et al. (1984) showed that the frequency of meal consumption is lower during the night shift. This is not surprising given the digestive system has its own circadian rhythm to time the secretion of gastrointestinal hormones and enzymes in anticipation of regular daytime eating patterns (Moore-Ede, 1993). Consequently, our stomachs were designed to shut down at night and process food more efficiently during daytime hours. This system becomes compromised with breakfast at sunset and supper at sunrise, and likely contributes to symptomatology over time.

Cardiovascular Effects

A profile of specific health problems identified as characteristic of "shiftwork-induced syndrome" include not just disturbances of gastrointestinal and sleep-wake systems, for example, but also disturbances to the cardiovascular system as well (Moore-Ede and Richardson, 1985). For example, aggregated studies of shiftwork occupations have found increased myocardial infarction risk compared with nonshiftworking employees (Akerstedt, et al., 1987). In fact, studies have suggested that increased duration of exposure to shiftwork is related to increased risk of heart disease, with the incidence being about 40% higher among shiftworkers compared to day workers even after controlling for other factors such as increased levels of smoking (Knutsson, 1989).

Shiftwork-related workplace stress has been proposed as a likely contributory factor, along with other variables such as increases in body mass and blood pressure (Barton et al., 1995). A single variable alone is likely not responsible for the reported findings in the literature; rather, a multidimensional model may better explain the results. For example, the literature further suggests that psychosocial aspects of a person's job may affect cardiovascular health. As well, hectic work, providing little decision latitude, was related to an elevated risk for MI (Alfredson, et al., 1982).

Moreover, Schnall et al. (1990) reported a relationship between job strain and elevated diastolic blood pressure (DBP). In some cases, there were also associated alterations in left ventricular mass index. Furthermore, Theorell et al. (1988) reported that systolic blood pressure (SBP) at work increased in situations with high demand-low decision latitude, and this finding was particularly evident among subjects with a family history of hypertension. In summary, exposure to occupational stress, or at least the perception of such exposure, is correlated with BP status and cardiovascular health (Sims, 1995).

When studying associations between stress and the risk for developing cardiovascular disease, however, it is important to consider that such relationships can be difficult to establish given individual differences in the perception of and response to stressors (Kasl, 1978; Morrison et al., 1985; Obrist et al., 1981). That is, what is stressful for one person may not be at all stressful for another (Ironson, 1992). Furthermore Zautra et al. (1987) found a significant interaction between task interest and stressful job events, thus an event itself is not always sufficient to produce a functional stressor across individuals.

Given this challenge, Sims (1995) suggested that a more objective physiological measure of stress be incorporated into studies comparing perceptions and outcomes. Specifically, Sims suggested that a comparison of the perception of stress between a group with high BP and a group of normotensives could potentially serve as an initial indication of the mediation of the physiological outcome of stress by individual differences in the psychological appraisal of stress.

Muscular Tension and Other Effects

Other physiological correlates of stress have also been studied (Beyers, et al., 2000). For example, Ekberg et al. (1995) showed that psychological stress can increase muscle activity, corroborating earlier findings dating back to Jacobsen (1931). Interestingly, women may be more vulnerable to musculoskeletal disorders, even when working under identical conditions as men (Evans, 1987). Furthermore, some individuals may be more susceptible to general muscular tension under stressful conditions, which may in turn make them more vulnerable to developing musculoskeletal pain and related symptomatology (Ekberg et al., 1995).

Moreover, several studies suggest that the demanding activities seen in shiftworking occupations such as Air Traffic Controllers may be a risk factor for stress-related symptomatology including headache, chronic fatigue, heartburn, indigestion, and chest pain, as well as a risk factor for illnesses such as hypertension, coronary heart disease, diabetes, peptic ulcer, and psychoneurotic disorders (Cobb and Rose, 1973; Crump, 1979; Fose et al., 1978).

Psychosocial Effects

Mood

Broadly, shiftwork research has until recently spent more time investigating shiftworkers' elevated risk for cardiovascular disease and gastrointestinal disorders than exploring issues relating to mental health, particularly in the United States. This is changing, however, as the conceptualization of shiftwork as a multidimensional stressor affecting both psychological and physiological processes emerges. Currently, the literature suggests that shiftwork can function as a significant stressor adversely affecting mood across a variety of indices. This is important, since mood disturbances such as depressive symptoms not only influence subjective states, but also adversely affect physical health (Schleifer et al, 1989) and productivity (Coyne et al., 1987).

Although an individual's current affective state can be influenced by a number of psychological, physiological, social, and situational factors (Prizmic et al., 1995), under controlled conditions mood can in fact exhibit a circadian rhythm. Furthermore, affective states have been shown to be adversely influenced by shiftwork, particularly the nightshift (Tasto, et al., 1978; Wynne et al., 1986; Bohle and Tilley, 1993). More specifically, Silverio (1997) found that nightworkers evidenced more symptoms of depression and anxiety. Costa (1993) further suggests that shiftworkers as compared to dayworkers are more likely to suffer persistent anxiety or depression requiring medical treatment with psychotropic drugs. Also, Koller (1983) found an increased prevalence of “psychoneurotic disturbances” including anxiety, nervousness, and restlessness among shiftworkers. Furthermore, shiftworkers are more likely to experience anger and irritability as compared to dayworkers (Frese and Semmer, 1986).

Consistent with the stress-diathesis conceptualization of ill-health, Cole (1996) suggested that if an individual has an existing predisposition to developing a mood disorder, then shiftwork can exacerbate the manifestation of the disorder. Interestingly, those shiftworkers who demonstrated greater flexibility in adapting to their work-rest schedules showed lower levels of depressive and anxiolytic symptomatology (Silverio). Also, Koller et al. (1981) noted that depressive symptoms among shiftworkers may be consequent to decreased well-being among this population, adding support to the multidimensional nature of shiftwork as a stressor.

Disturbances to Domestic Life

Currently, women are still more likely than men to experience major domestic commitments centering around child care. In fact, Presser (1986) suggests that some women elect shiftwork in general and night work in particular because it better matches their domestic commitments. Studies have shown that female night workers that are primary care givers of younger children slept on average one hour and twenty minutes less compared to male counterparts and to women without children (Gadbois, 1981; Oginska et al., 1993).

More generally, working at unusual times of the day can result in a range of domestic problems for shiftworkers (Barton et al, 1995; Lehrer, 1998). By displacing the worker in both time and space, schedules requiring nightwork can lead to domestic inconveniences for the employee, a significant other, and other members of the family to the extent that they could have deleterious effects on family relationships (Walker, 1985).

Additionally, situational circumstances at home may preclude needed sleep periods, especially if the shiftworker has the double burden of also being the primary "homemaker." Monk and Folkard (1992) further suggest that reduced time for sleep, social activities, and "parent" activities such as attending open house at school can contribute to feelings of irritability that tend to exacerbate existing family problems.

Disturbances to Social Life

Shiftworkers also often experience difficulty in maintaining a satisfying social life given the added difficulty they face in participating in interactive activities and hobbies. Not surprisingly, many clubs and societies are convening while the shiftworker is on the factory floor. The scheduling of such community activities may serve to create additional feelings of alienation from the community at large (Barton et al., 1995). Furthermore, shiftworkers typically have fewer friends than day workers, and those they do have tend to be shiftworkers themselves (Walker, 1985; Lehrer, 1995). For example, many shiftworkers have reported striking up friendships at work to pass the time.

Although some shiftworking organizations have attempted to organize after-hour clubs and teams within the organization itself, anecdotal results suggest that such efforts are largely unsuccessful, perhaps because many employees want to distance themselves from the work environment after hours. Alternatively, anecdotal evidence also suggests that workers are fatigued by shift's end and want to go home to see their family and/or attend to requisite responsibilities before attempting daytime sleep.

Summary

The literature depicts the negative impact of shiftwork stress across a number of performance, physiological and psychosocial indices. Broadly, attenuation in nighttime alertness as compared to the day is reliably predicted in the literature. Physiologically, shiftwork is associated with an array of negative outcomes, including increases in gastrointestinal disturbances, cardiovascular disease, and muscular tension. Psychosocial effects include higher rates of mood disturbances such as depression and anxiety, as well as disturbances to domestic and social life.

Chapter 3: Shiftwork Stress Moderators

At a general level, the present study proposes that outcomes relating to biopsychosocial adjustment, safety, and performance are mediated via coping processes and driven by effects of situational characteristics, individual differences, and social resources. Common sense suggests that there exists the potential for numerous shiftwork stress moderators such as motivation (Theorell & Karasek, 1996), napping strategies (Gillberg, et al., 1996), and morningness (Monk & Folkard, 1985; Kecklund et al., 1997), for example; however, a primary focus is given to those moderators considered most salient and directly linked to the present study's core set of hypotheses. Specifically, the chapter examines coping processes and the moderating roles of demand, control, and support variables on subsequent adjustment. Then, the demand-control model of stress and strain (Karasek, 1979) is introduced. The chapter closes with a review of important methodological challenges in shiftwork stress research.

The literature review in Chapter 1 illustrated that the determinants of coping behavior have been conceptualized in different ways. Broadly, whereas some studies consider coping as a response to the characteristics of the particular stressor (Coyne et al., 1981; Folkman et al., 1986; Mattlin et al., 1990; McRae, 1984), other investigations have conceptualized coping as reflecting personal characteristics contributing to the utilization of consistent coping styles over time and across various stressful situations.

However, the concept of maintaining consistent individual coping strategies has not been particularly successful (Folkman and Lazarus, 1982; Moos and Billings, 1982). Currently, a consensus previously described by Folkman and Lazarus (1984) appears to exist and argues that coping behavior is influenced by qualities of both the stressor and the person. Consequently, the following discussion of shiftwork stress moderators will incorporate both demand characteristics and individual differences as well as the effects of social resources in predicting stress outcomes.

SITUATIONAL CHARACTERISTICS OF WORK-REST SCHEDULES

As noted earlier, work-rest schedules are particularly important when considering the overall decrement in performance that occurs during the nightshift (Eilers and Nachreiner, 1990). This can be especially true for jobs requiring sustained, vigilant monitoring, where the equipment is often so technologically advanced that manual intervention is greatly reduced and primarily necessary in response to a critical situation such as an alarm.

Given that characteristics of a particular situation can affect coping efficacy (Coyne et al., 1981; Folkman et al., 1986; Mattlin et al., 1990; McRae, 1984; Smith et al., 1998), the chapter now considers salient work-rest characteristics that potentially moderate efforts at coping with shiftwork stress. These include considerations of eight versus twelve hour shifts, fixed versus rotating shifts, and the number of consecutive shifts worked.

Eight versus Twelve Hour Shifts

Debate over the benefits and liabilities of eight versus twelve hour shifts constitutes a significant and volatile segment of shiftwork stress research (Lehrer, 2003). Currently, no clear consensus has been reached, and the debate continues (see Baker, 1995 for a review), although at a general level support for 12 hour shifts has increased in recent years.

Whereas some findings suggest that 12-hour shifts may be associated with increased fatigue and decreased performance, other studies have not found any significant fatigue increases or associated performance decrements (Duchon and Smith, 1992). Still other findings suggest benefits of 12 hour shifts in terms of psychological well-being, physical health, social and domestic life, and work attitude (Tucker, 1996).

Nonetheless, European nations in particular have been slow to accept 12 hour shifts, perhaps in part due to cultural differences regarding work and leisure time expectations as compared to the United States and Canada. Arguments against such hours of service have in the past been strongly expressed by European researchers. Recently, however, Sweden's Akerstedt (1997), a leading member of the shiftwork researcher community, noted that "we've been saying for some time that 12's are bad, and now there's a growing body of research that shows they're not so bad– or at least no worse than 8's."

As empirical research slowly replaces emotion and volatility, it appears likely that the benefits and liabilities of a shift's duration will need to be weighed against the site-specific operational conditions in conjunction with the needs of the particular workforce in question (Lehrer, 1996). Consequently, it is likely more important to consider the goodness of fit between any schedule and the operation's unique requirements; that is, knowing specific features of an 8- or 12-hour schedule as well as informed site-specific preferences may be more informative in predicting efficacy than merely classifying a shift by duration alone.

Fixed versus Rotating Shifts

There is considerable debate in the literature as to the advantages and disadvantages of fixed versus rotating shift schedules (Folkard, 1990; Monk, 1986; Canadian Centre for Occupational Health, 1998). Much of the debate argues whether it is healthier to stay on a night shift to enhance stability or to instead rotate through it to spend less overall time working nights. Although some studies have proposed that nurses working rotating shifts may experience higher levels of job-related stress (Coffey et al., 1988), less sleep (Lee, 1992; Akerstedt, 1996), and more health complaints (Verhaegen et al., 1987) than do fixed nightshift nurses, comparisons between the two groups are complicated by the fact that the nightshift is not the only problematic shift. In fact, the early day shift (e.g., starting at 6 a.m. and in some instances requiring waking between 4 and 5 a.m.) and not the night shift was found to be most problematic in terms of mood disturbances and sleep duration (Folkard, 1990). Similarly, Bauer (1993) found that an early start on the morning shift places nurses under considerable stress.

Consequently, Barton et al. (1995) suggest that it may be more appropriate to conduct investigations at the level of specific organizational features as opposed to the shift structure as a whole. Further, it is informative to determine to what extent similar, but in some aspect differing types of scheduling changes vary in their effects on the workforce (Hornberger and Knauth, 1995). One such example is the number of nights consecutively worked, since the effects of such parameter changes can be informative in both fixed and rotating environments.

Number of Shifts

The number of consecutive shifts does appear to be an important factor when considering effects on well-being. For example, more consecutive night work for permanent night nurses was predictive of longer sleep duration between night shifts, which in turn was predictive of better quality sleep. Better quality sleep predicted better psychological health, less chronic fatigue, and fewer symptoms of physical illness (Barton, 1995). Thus less rapidly rotating schedules may provide more circadian stability for the worker and consequently enhance efforts at managing physical and psychological stress.

However, after five consecutive nightshifts, alertness tends to be reduced absent any recuperative days off (Lehrer et al., 1993). In other words, it may be more advantageous to work smaller clusters of nights, such as two or three in a row, followed by a similar period of days off and a subsequent return to nightwork before switching to a similar daytime schedule. In this way the employee avoids any one stretch of nights that may prove problematic.

Summary

Several variables are incorporated into schedule design processes, including shift duration, rotation, and pattern of consecutive work days, and each can influence a schedule's overall efficacy in terms of health, safety, and productivity as a result of its fit with a particular workforce under specific operating conditions. The challenge then is to select the optimal schedule given the unique, site-specific circumstances of an operation. Adequate consideration for such specificity of fit is often important not only within the same industry but also within the same company and even at the same location.

INDIVIDUAL DIFFERENCES

Several studies have suggested that factors relating to individual differences such as flexibility and locus of control orientation can moderate an individual's reaction to shiftwork. For example, Davies et al. (1983) emphasized the role of individual differences in predicting susceptibility to boredom and distractibility when performing monotonous tasks such as those encountered in various shiftwork settings. Accordingly, the chapter now considers important individual differences that can potentially affect an employee's ability to cope with shiftwork stress. First, areas of primary interest will include flexibility, locus of control, and the opportunity to exercise control. Next, age, years of shiftwork and gender will be discussed as areas of secondary interest.

Flexibility

Folkard et al. (1979) found <u>flexibility</u> to be positively associated with measures of circadian adaptation to night work. Also, Verhaegen et al. (1987) and Isra-Golec and Pokorski (1990) found flexibility related to shiftwork tolerance as determined by the frequency of health and sleep complaints. Thus those workers who can more easily adapt their lifestyles to meet work schedule demands tend to experience greater overall adaptation to shiftwork. A more detailed consideration of flexibility will be presented in Chapter 4's discussion of the present study.

Shiftwork-Specific Locus of Control

In response to the generic nature of the original LOC construct, a number of domain specific scales have been developed, including health behavior (Coelho, 1980), economic behavior (Furnham, 1986), and work behavior (Pettersen, 1985; Spector, 1988). These measures better operationalize the construct in specific situations (Spector, 1988) as compared to the more generalized internal-external scale developed by Rotter (1966).

At a general level, shiftwork-specific personal control expectancies may moderate the deleterious impact of shiftwork (Smith et al., 1995). More specifically, Smith et al. (1995) found that shiftwork specific locus of control beliefs may play a significant role in moderating shiftwork-related impairment to health, social life, sleep, and effectiveness at work. For example, a shiftwork-specific measure of <u>internal shiftwork locus of control</u> (SHLOC) was related to more structured use of time, which in turn related to better coping with shiftwork (Smith, 1995).

Internality on the SHLOC was also positively related to alertness and flexibility of sleeping habits (Akerstedt, 1990; Costa et al., 1989), a significant finding given that these variables are thought to be connected with increased tolerance to and safer performance during shiftwork. High internals also reported experiencing better psychological health and the ability to more easily overcome drowsiness. Conversely, internal shiftwork locus of control was negatively related to poor mental well-being, sleep disturbance, and work stress (Smith et al., 1995).

In summary, the SHLOC construct may be a relatively enduring personality trait that can be utilized to better understand the physical and psychological factors underscoring existing buffers to shiftwork stress. Moreover, high internals would be expected to have fewer health, sleep, and safety problems because they would mobilize more resources and gather more information to prevent or control such problems since they believe that their actions significantly influence outcomes.

Opportunity to Exercise Control

Given the link between control expectancies and well-being, it is important to examine methods for facilitating control. For example, an organization can facilitate perceptions of control by providing opportunities for meaningful participation in important decision-making processes (Ganster, 1988; Sutton and Kahn, 1987). Such increased participation in the decision making process may foster changes in an employee's appraisal of the controllability of specific worksite stressors (Heaney et al., 1995) and yield practical consequences given that situational control beliefs have been positively related to active, problem-focused behavior aimed at coping with stress (Folkman, 1984; Carver et al., 1989, Terry, 1991).

However, despite the theoretical and practical importance of worksite studies of control, Heaney, et al. (1995) noted that the effects of opportunities for control over worksite stressors on employee coping behavior had not been studied to date. Interestingly, one conceptual challenge concerning employee work site control is discerning whether the <u>participation</u> in the decision process or the <u>outcome</u> of the decision itself is most meaningful for employees (Bernstein, 1976; Walker, 1974).

Theoretical analyses emphasizing the role of personal control suggest that perceived influence will likely be more positively associated with employee coping behavior than the act of participation itself (Folkman, 1984). Similarly, Heaney (1995) found that perceiving oneself to have influence over work-related decision making predicted increases in active, problem-solving coping efforts and decreases in resignation associated with worksite stressors. Smith and Barton (1994) further suggested that levels of personal control relating to shiftwork can significantly moderate dysrhythmic work schedule effects among shiftworkers. For example, the amount of control given to employees in deciding work hours has been shown to affect shiftworkers' ratings of shiftwork tolerance (Barton et al., 1993).

Age

Akerstedt and Torsvall (1981) suggest that age is an important factor in individual adjustment to working shifts. More specifically, the literature suggests that there is a certain age in the late 40's or early 50's at which shiftwork becomes increasingly difficult to sustain (Barton, 1995, Heslegrave, 1998). Anecdotally, this pattern of change in perceived tolerance levels to shiftwork is broadly observed.

Consistent with this observation, sleep patterns also change with age as an older person's sleep becomes shorter and more disrupted; that is, circadian rhythms tend to desynchronize more easily. Also, rhythms tend to show decreased amplitude (Akerstedt and Torsvall, 1981). Consequently, older people tend to sleep fewer consecutive hours and supplement this loss of sleep with naps during the day (Monk, 1989; Rosa et al., 1990). Thus, the age of a shiftworker can negatively affect their tolerance to nightshift work (Spelten et al., 1995).

Four contributory factors have been proposed as possible explanations for this apparent change in adaptability: cumulative negative shiftwork effects, an overall weakening of worker health and concurrent decrease in worker ability to cope with stress, a flattening of circadian rhythms with age, and a tendency towards more fragile sleep and morningness (Monk and Folkard, 1985). Interestingly, the latter factor supports the notion that increasing age may facilitate adaptation to early morning shifts (Härmä, 1993). Monk (1991) further argues that reduced tolerance may be related to a disturbance of the entrainment mechanism, disrupting the ability to ensure correct period length and temporal alignment of various circadian rhythms. Alternatively, it is possible that advancing age is associated with a weakening of time cues rather than degenerative changes to the entrainment mechanism itself (Barton et al., 1995).

Years Working Shiftwork

Longitudinally, shift-specific components of health impairment can be separated from other non-shift related components (Nachreiner et al., 1995); in fact, there appears to be a change in the structure of health complaints with increasing shift experience. After about 10 years of shiftwork, the factorial structure of health complaints was different than that of workers with little shift experience (Beermann and Nachreiner, 1990). Whereas the latter group evidenced a rather undifferentiated pattern of complaints, those workers with 10 or more years of shifts demonstrated a pattern in which complaints relating to circadian functions (i.e., sleep disorders and gastrointestinal disturbances) comprised one factor while other symptoms loaded on an orthogonal second factor. Thus both the frequency of complaints and their internal relationship appear to change with shift experience.

Gender

Although some researchers suggest that there are different effects of shiftwork for men and women, other findings do not support such a difference (Costa et al., 1990; Dekker and Tepas, 1990; Rutenfranz et al., 1987). One reason for the lack of agreement is the dearth of comparative studies on the effects of shiftwork on men and women working the same job under comparable working conditions to ensure that confounding effects of gender-related working environments are minimized (Beermann and Nachreiner, 1995).

Unfortunately, much of the literature attempting to tap gender-related differences originates from samples that also differ in meaningful and important ways with regard to working conditions. For example, conclusions drawn from a population of largely female nurses likely reflect more than gender differences when comparing outcomes to a population of largely male haulers in a mining operation. Therefore, there exists a need for studies in which statistically sound samples of both women and men are performing the same function under the same scheduling and work conditions.

Some meaningful gender differences have been reported, however. For example, Lim (1995) showed that females use social support as a coping skill more than males do. Interestingly, studies also suggest that insomnia complaints tend to increase more rapidly with age among women than men (Kripke et al., 1979), thus suggesting an interaction between gender and age effects may exist.

Summary

Individual differences impact adjustment to shiftwork stress. In particular, flexibility and locus of control orientation can significantly affect biopsychosocial and health-related outcomes. As well, age and years working shifts are moderating variable that can potentially influence one's ability to successfully cope with the challenges of shiftwork stress. More research is needed to explore the important consideration of gender as a shiftwork stress moderator.

SUPPORT RESOURCES

Support has been shown to influence physical and psychological health (Pisarski, 1997), and a large body of research has found that supportive social relationships are central to psychological adjustment (Cohen and Wills, 1985; House, Landis, and Umberson, 1988). Therefore, the chapter now turns to a discussion of relevant support processes that can moderate efforts at coping with shiftwork stress. Primary emphasis is placed on a discussion of social support as it relates to the present study, both at and away from the workplace, including a discussion of negative support. The chapter then highlights important peripheral considerations of support, including organizational support and a transactional view of support.

Social Support

The supportive quality of social relationships, termed <u>social support</u>, can be conceptualized as a resource that individuals engage in when coping with stress (Thoits, 1986). For example, social support protects individuals from manifesting depression under high stress demands (Cohen and Wills, 1985). Increasingly, the role of an individual's <u>perception</u> of social support is viewed by researchers as significant in determining the adaptive value of social relationships (Pierce, Sarason, and Sarason, 1991). This is important, since studies show that perceptions of available support only relate moderately to actual support received (Cutrona, 1986). In fact, Wethington and Kessler (1986) found that perceived availability of social support related more strongly to mental health outcomes than actual levels of support received.

Broadly, social support can enhance adjustment under stressful conditions by facilitating positive appraisal and adaptive coping processes (Cohen and McKay, 1984; Thoits, 1986; Holahan and Moos, 1990, 1991). More specifically, social support, or at least its perception, can attenuate the effects of stress in at least three ways. First, social support can aid an individual in modifying a stressful situation to better deal with the current stressor (Heaney, et al., 1995). For example, guidance, advice, and enhanced access to pertinent information are all ways in which such support can benefit an individual.

Second, social support can provide a new perspective on the nature of a particular stressor. Stryker (1981) noted that according to the theory of symbolic interactionism, individuals assign meaning to outcomes and develop individual self-evaluations through social interactions. Third, social support can attenuate emotional upset associated with a stressful situation (Heaney, et al., 1995).

Social Support at Work

An important function of work relationships is that they can provide social support (Heaney et al., 1995); that is, they serve as "interpersonal exchanges of affect, affirmation and aid" (Kahn and Antonucci, 1980). In fact, co-workers and supervisors can aid in defining role expectations and can attenuate the seriousness or threat of specific organizational demands (Wells, 1982). Moreover, Karasek, et al. (1982) found that for both instrumental and emotional supervisory and co-worker support, a higher level of support was associated with a weaker link between task stress and mental strain.

As well, Heaney et al. (1995) and Lehrer (1997) suggested that employees who perceive their work relationships as supportive are more likely to seek and accept assistance from co-workers and supervisors during periods of worksite stress. Furthermore, they suggested that such employees are also more likely to attempt to solve problems because of the perception that cooperation and aid will be available from co-workers and supervisors.

Social Support Away From Work

Studies of non-worksite coping behavior have also demonstrated the buffering effects of social support when coping with stress. For example, studies have shown that individuals with a supportive family environment are more likely to engage in active coping strategies and to seek emotional support when faced with a stressor (Cronkite and Moos, 1984; Holahan and Moos, 1987), particularly when under high stress levels (Holahan and Moos, 1991). Also, Heller, Swindle, and Dusenbury (1986) suggested that social support processes involving socializing and companionship enhance appraisals of self-esteem, which in turn relates to psychological health (Cohen and Syme, 1985).

Moreover, because workplace stress is an effect of both job-related stress and to some extent an interaction between off-job and on-the-job stress, a measure of <u>domestic support</u> will likely inform a measure of stress experienced at the worksite (Beermann and Nachreiner, 1995, Lehrer, 1994). For example, a perception of marital support regarding both the employee’s participation in shiftwork and a willingness to aid in facilitating adaptation to irregular hours could positively affect efforts at coping with shiftwork stress. To date, no adequate study has been performed to assess the contributions of domestic and social support away from the workplace in determining shiftworkers' physical health, psychological health, or safety.

Interestingly, when studying effects of social support away from work, it is also important to consider that women have traditionally been more likely to experience the double burden of both working outside the home and also being the primary caregiver, and may therefore receive less support themselves in the home environment. Thus, gender alone may not sufficiently account for differences evidenced among shiftworkers even when working similar jobs under similar conditions. An exploration of levels of domestic support and compensatory coping strategies may, however, provide insight into how such double duty employees adjust to their particular circumstances.

Negative Support

Whereas most studies have focused on the positive nature of social support, other researchers have underscored the negative aspect of social support; that is, being "let down" by others (Brown et al., 1986; Finch et al., 1989). Being disappointed by others may attenuate psychological well-being in at least two ways (Daniels and Guppy, 1995). First, negative support may inhibit achieving the social psychological needs that Cobb's (1976) previously described three components of support can provide. Second, negative support may inhibit the engagement of supportive behaviors that could otherwise have been helpful with an individual's problem. Interestingly, poor social support has also been associated with hypertension (Sims, 1995).

Organizational Support

Perceived organizational support is a personal resource that reflects the extent to which workers believe their personal needs to be considered by, and their contributions to be valued by the organization (Dekker and Barling, 1995). Perceived organizational support has also been shown to be positively related to attitudinal and behavioral measures of affective attachment (Eisenberger, et al., 1990).

Still, little is known concerning the organizational factors that contribute towards perceived support (Dekker and Barling, 1995). Eisenberger et al. (1990) suggested that benefits provided by the organization that are perceived as discretionary as opposed to negotiated or mandatory may lead to a sense of positive regard for the employee and associated increases in levels of perceived organizational support.

Transactional View of Support

Interestingly, contrary to traditional views in which environmental factors and individual differences have been conceptualized as influencing coping behavior (Heaney et al., 1995), Lazarus and Folkman (1984) suggest a transactional view of the stress processes whereby the way individuals cope may affect both the social environment and personal dispositions. That is, in addition to the effect of organizational support on employee coping behavior, the individual's engagement of specific coping strategies may influence the employee's ability to mobilize and/or maintain supportive social relationships.

For example, Dunkel-Schetter et al. (1987) showed that others were more likely to provide social support when an individual engaged in problem-solving and positive reappraisal strategies to cope with stressors. This suggests that people are more likely to help others whom they perceive as constructively coping with their problems. Consistent with this idea, Heaney (1995) showed that the more an employee tended to mobilize support under stress, the more supportive his or her co-workers were perceived to be.

Summary

The social support literature has important practical implications for the employee. Systematic efforts to increase perceived social support may result in increased employee effort to mobilize support during stressful circumstances. Consequently, employees may engage in more effective coping strategies through a better utilization of available co-worker and supervisor coping resources. Moreover, support from significant others external to the workplace also likely benefits coping efforts at work, and has not been adequately studied to date. Interestingly, negative social support can hinder coping efforts and may contribute as much or more to diminished levels of adjustment than a lack of positive support. More research is needed in the area of organizational support to gauge its effectiveness in stimulating adaptive coping behavior, while transactional support research suggests that increased coping through active problem solving may in turn facilitate increased levels of social support, thus optimizing available resources.

THE DEMAND-CONTROL MODEL

Although numerous constructs have been postulated to explore relationships among variables in the formulation of theories regarding workplace stress (see Dunnette and Hough (1992) for a thorough review), Karasek (1979) provides an especially useful model for exploring stress among shiftworking populations.

Conceptual Antecedents

Several studies concerning work demands and work hours were conducted in the 1960s to explore, among other things, the effects of job conditions on heart disease (Theorell and Karasek, 1996). Sources of risk underlying these findings, however, were equivocal, and much of the research centered not on the work itself but rather on life events away from the workplace.

During the following decade, many critical observations helped foster the conceptualization of Karasek's (1979) demand-control model. Sundbom (1971) observed symptoms of psychological strain under "mentally heavy work" conditions, in which monotonous tasks were inferred to represent attenuated control. As well, Seligman (1975) noted that depression and learned helplessness tended to occur under conditions of intense demand coupled with restricted control. In fact, behavioral outcomes in both of these studies appeared to be influenced by the combined characteristics of demand and control variables. A factory worker's packaging of pies into boxes along a conveyor belt at an unrealistically increasing speed of presentation serves as a conceptual analogy here.

Moreover, Karasek (1974, 1976) observed that job related behavioral outcomes and health appeared to be causally related to the combined influence of work-related psychological demands and structural job characteristics with respect to one's freedom for decision making and skill utilization. Also, Kohn and Schooler (1973) observed that an active job orientation followed both high autonomy and high skill levels in the context of psychologically demanding tasks. Interestingly, Csikszentmihalyi (1975) showed that the active experience of "flow", during which an individual focuses attention on a clearly defined goal, was a consequence of tasks involving both psychological challenge and high degrees of competence.

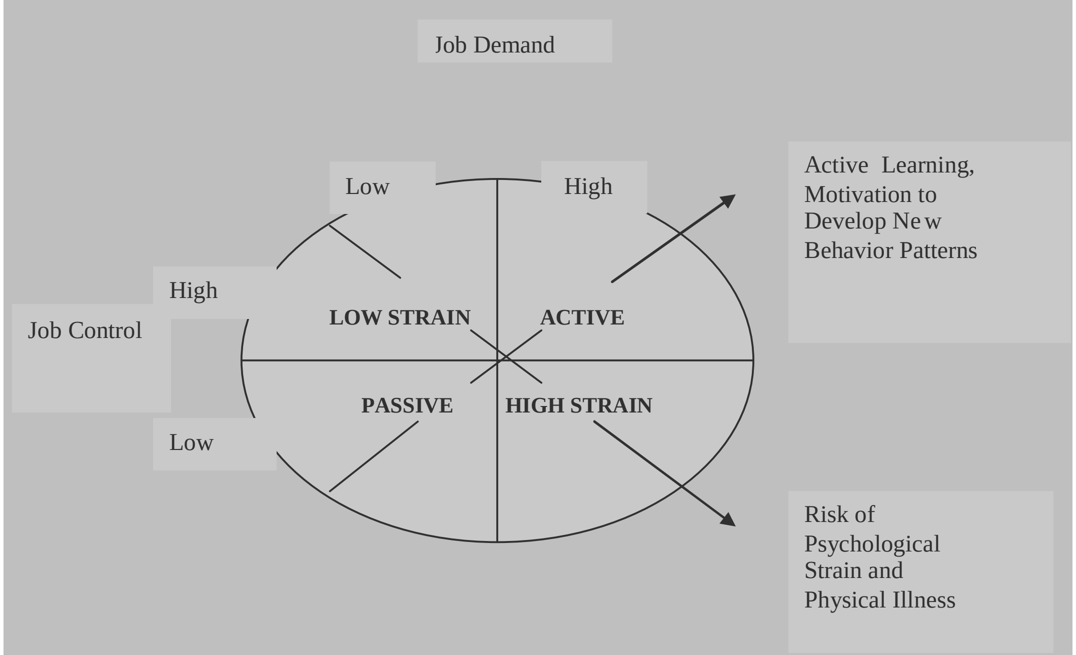
Lehrer (1985) later found that individuals performing tasks requiring higher levels of sustained attention and creativity tended to be less aware of the passage of time, consistent with Csikszentmihalyi's (1975) earlier description of flow states. Such tasks can be conceptualized as less boring and perhaps less stressful so long as the task stays within reasonable limits of one's capacity to selectively attend.

Original Conceptualization

Karasek (1979) integrated previous research and subsequently presented a model of both theoretical and practical importance in exploring dynamic processes relating psychosocial work environments, stress, and ill-health. The resulting "demand-control" model has subsequently been used in psychological, medical, and epidemiological research, and has been described as the most influential model of the past 10 years concerning research on the behavioral and health effects of inherently stressful work environments (Kristensen, 1995).

At a broad level, the demand-control model postulates that job demand and decision latitude form two core dimensions that allow for identification of four distinct job categories (Karasek, 1979). More specifically, job demands represent mental work load and arousal demands, including both qualitative and quantitative demands as well as demands of interpersonal interactions. Decision latitude is conceptualized as the possibility to develop and use skills (skill utilization) coupled with one's authority level for decision making. The model predicts one of four job types by categorizing both demand and control variables as either low or high.

As demonstrated in Figure 1 (page 74) high strain jobs are conceptualized as high demand/low decision latitude positions, whereas low strain jobs are conceived of as low demand/high decision efforts that are inherently more relaxing. As well, active jobs are construed as high demand/high decision duties, whereas passive jobs are operationalized as low demand/low decision assignments. Moreover, Karasek's (1979) model hypothesizes that the poorest levels of psychological well-being and the greatest levels of symptoms and ill health are evidenced among high strain environments.



After Karasek (1979). Adapted from Schnall, P.L., Landsbergis, P.A., & Baker, D. (1994). Job Strain and Cardiovascular Disease. Annual Review of Public Health, 15 ; 381-411.

Figure 1. Karasek Demand Control Job Strain Model.

The model has received substantial empirical support, as numerous health problems have shown positive associations with high strain jobs, including depression, cardiovascular disease (CVD), fatigue, sleeping disorders, anxiety, psychiatric illnesses, upper back pain, and gastrointestinal disturbances (Payne, et al., 1984; Theorell, et al., 1988; Karasek, et al., 1982; Warr, 1990). As well, a number of adverse behavioral outcomes have also been associated with high strain, including absence from work, occupational accidents, and traffic accidents (Theorell and Karasek, 1990).

Interestingly, findings associated with the model strongly suggest, contrary to some initial beliefs, that psychosocial stress is not merely a problem relegated to high level executives with significant responsibilities; rather, it is a distributed burden shared among working class employees as well (Theorell and Karasek, 1996). Karasek's model further suggests that positive outcomes such as individual development, enhanced social opportunities, and learning are most likely manifested in active as opposed to passive work classifications (Kristensen, 1995). At a conceptual level, Theorell and Karasek (1996) suggest that such active jobs produce a "desirable stress" leading to heightened motivation.

Revision of the Original Model

In the past decade a revision to the two dimensional job strain model added a third dimension of <u>job social support</u> (Johnson, 1989; Karasek and Theorell, 1990). This extended demand-control-support model theorizes that the greatest risk of ill-health is predicted in the iso-strain group combining high demand, low control, and low social support at work.

For example, Karasek and Theorell (1990) described a number of studies that together suggest an increased risk for cardiovascular disease (CVD) among individuals working under the stressors of high demand, low control, and low support. Similarly, they suggest a positive relationship exists between job strain and systolic blood pressure.

Summary

In the past two decades, research concerning shiftwork has broadly crafted the general consensus that shiftwork can impose considerable stress upon the individual both at and away from the workplace. The literature further reports that high strain jobs, as defined according to Karasek's (1979) demand-control model and subsequent revisions incorporating a dimension of work support, adversely influence health and quality of life across a wide range of outcomes.

METHODOLOGICAL CHALLENGES IN SHIFTWORK STRESS RESEARCH

Kristensen (1995) suggests that methodological improvements would better inform research exploring the nature, causes and effects of shiftwork stress. Moreover, a number of important criticisms have emerged suggesting opportunities for enhancing the validity of future studies. The chapter now considers these criticisms to provide the conceptual underpinnings for crafting methodological improvements in the present study. The critique will focus on experimental design issues relating to intervention, variation of exposure, method of measurement, longitudinal design, control groups, response rate, generalizability, and sample size.

Intervention

Much of the literature, particularly regarding shiftwork, is relegated to theoretical studies describing health and behavioral deficits without concomitant efforts to mitigate adverse outcomes. Thus there exists a paucity of intervention research (Kristensen, 1995). Such efforts are needed to test hypotheses and fine tune strategies to ultimately aid populations in attenuating and/or coping with identified stressors.

Variation of Exposure

Numerous studies have been based on homogeneous "representative" samples without any specific job descriptions to distinguish subject populations. As Kristensen (1995) observes, many studies even call attention to this representativeness as a positive study feature. Yet, whereas purely descriptive studies seek out representative samples, analytical studies attempting to elucidate possible causal pathways derive little benefit from representative samples; rather, it is the variation of exposure that informs.

Thus differentiated, well-described exposures to relevant stressor categories are more informative in exploring causality. Without such variability, it is difficult to infer whether qualitative or quantitative distinctions in job-specific stressors, particularly at the same site or in the same occupational field, reliably predict unique outcomes. Also, the lack of independent job descriptions prohibits a comparison of such descriptions with ratings from the workers themselves. Moreover, without specific knowledge concerning individual jobs, it becomes more difficult to explore coping strategies in an ecologically valid manner.

Methods of Measurement

Another methodological challenge is the manner in which job dimension stressors, stress levels, and ill-health are often measured. Each is now considered and organized according to a holistic matrix approach described by Kristensen (1995).

Measures of Job Dimension Stressors

Job dimension stressors can be measured in several ways. The "subjective" (self-rated) method, in which each employee responds to questions concerning job demands, control, and support (Kristensen, 1995), can bias dimension scores since workers with poor health or poor psychological adjustment tend to report increased levels of job stress as compared to healthier and better adjusted employees. This problem is especially relevant in cross-sectional and case study investigations (Kasl, 1987). Accordingly, longitudinal studies are indicated to mitigate the potential for confound.

Another way to alleviate the subjectivity problem is to incorporate measures of average values of job dimension responses among employees working similar jobs; that is, job 1 employees would all be identified at one position in the demand-control-support framework, while job 2 employees would together be located at a different position. Similarly, behavioral outcome measures such as accidents and injuries could be reported as group averages by job classification.

By integrating both self-rated and averaging methods in the job strain model, the investigator can also study how the two measures interact. For example, Winkleby, et al. (1988) and Netterstrom and Suadicani (1993) propose that "deniers" (jobs with average high strain, but self-rated low strain) may have less favorable prognoses compared to coworkers who do not deny workplace stressors. As well, studies of "complainers" (average low strain, but self-rated high strain) may further inform inquiries into job-related health and behavioral effects.

Job dimension characteristics can also be assessed independently of the employees undergoing exposure. Some examples include: industry turn in warehouse operations, cycle time in assembly line work, number of transported loads in mining operations, and number of flights in air traffic control operations. Also pertinent are work descriptions given by industry experts, various observational methods, and the use of production figures (Kristensen, 1995). Where possible, the use of such independent measures in conjunction with self-rated and averaging techniques stands to enhance understanding of the psychosocial processes involved.

Measures of Stress Levels

Much as stressors can be measured in at least three important ways (self-rated, averaging, independent), so too can corresponding stress levels among individual workers. First, self-rated correlates of stress such as anxiety, irritability, and anger can be obtained. Second, physiological indicators of stress such as cortisol levels and blood pressure represent a useful tool to measure the stress construct. As well, where physiological measurement is not possible, relatively objective self-reports based on the recall of actual medical diagnoses (e.g., high blood pressure, CVD) can be more informative than merely assessing subjective health complaints. Third, behavioral correlates of stress such as absences and accidents can provide additional objective data. Thus, whereas interpretation of any one type of stress measure may be tenuous, an integrated triangulation of the construct yields a more efficacious analysis.

Measures of Ill-Health

Finally, ill-health can also be measured in at least three complimentary ways. First, ill-health at the level of disease can be medically diagnosed, preferably via medical records but also via worker report. Second, ill-health can be inferred as a function of worker complaints established via self-report. Third, ill-health can be inferred via impairments to employee functional ability to perform job duties as well as responsibilities outside of the work environment.

Kristensen's 3S-Matrix

Kristensen (1995) adroitly organizes the above multitrait, multimethod approach into a useful 3S-matrix to facilitate methodologically sound investigations of relationships among stressors, stress, and ill-health (sickness, hence 3S), achieved by triangulation of each construct under consideration. As Table 1 demonstrates, Kristensen's 3S matrix allows for the integration of 45 unique matrix combinations. Applying prior theoretical research (Campbell and Fiske, 1959) validity is likely strengthened as multiple traits and measures are realized and integrated into subsequent analyses.

Table 1. The 3S-Matrix: Relationships Among Stressors, Stress and Sickness

			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Stressors	Independent	(1)	1	2	3	4	5	6	7	8	9
	Self-rated	(2)		10	11	12	13	14	15	16	17
	Average	(3)			18	19	20	21	22	23	24
Stress	Physiological	(4)				25	26	27	28	29	30
	Self-rated	(5)					31	32	33	34	35
	Behavior	(6)						36	37	38	39
Sickness	Disease	(7)							40	41	42
	Illness	(8)								43	44
	Functional ability	(9)									45

Adapted from Kristensen (1995).

Longitudinal Design

Interestingly, most studies exploring "best" working hour arrangements have employed cross-sectional retrospective questionnaire designs as opposed to <u>longitudinal</u> momentary self-reports, despite findings that the latter reports were less susceptible to stereotyped responding (Totterdell et al., 1995). The longitudinal design is also better suited to assess finer grained changes both between and during shifts. Moreover, whereas cross-sectional relationships are subject to a number of interpretations due to the potentially reciprocal nature of coping resource variables and behavioral outcomes, a longitudinal design better informs an assessment of causality.

In the current literature, only a few studies on the implications of shiftwork are based on a longitudinal design. At least two reasons partly explain the paucity of such studies. First, the relative increases in both time and costs incurred in such a pre- and post-measure analysis can be prohibitive. Second, field studies are typically less popular in industry for fear of interfering with the business of production, and hence the production of business.

Control or Quasi-Control Group

Those studies that have applied a longitudinal design have often shown methodological shortcomings, such as the lack of any <u>control group</u> (Totterdell and Folkard, 1990). Oftentimes all workers undergo the identical organizational change, thus making it difficult to distinguish confounding effects from that of the change itself. Thus there exists a paucity of shiftworker studies employing a control or quasi-control group in their analyses.

This is unfortunate, since the value of including a control group is well established in applying the scientific method of inquiry in general and in psychological research methodology in particular (Goodwin, 1995). Consequently there exists a need for methodologically improved investigations in which a control or quasi-control group is present. Yet companies investing money to optimize performance are interested in meeting both near-term as well as long- term goals, and thus tend to change schedules on an all-or-none basis absent any control group to allow for scientific study of potential improvements.

Furthermore, at an organizational level, industry is often quite interested in knowing that something works and perhaps at times less interested in the mechanics of why or how positive change is effected. Thus if an organization is supportive of an intervention's efficacy, the operation understandably has a vested interest in maximally engaging the intervention; that is, a control or quasi-control group may not be within the realms of operating boundary conditions.

Despite this challenge to more rigorous shiftwork stress research design, there exist organizations willing to scientifically test interventions in order to achieve longer range goals. Such decisions often stem from senior level management, however, since such field research usually has implications beyond the productivity of any one site and therefore beyond a plant manager's accountable production interests, for example.

Ecological Validity

The ecological validity of prior shiftwork stress research has often been compromised due to issues concerning response rate, generalizability, and sample size. Each is now discussed as a further methodological challenge in shiftwork stress and coping research.

Response Rate

Many designs in the literature have employed questionnaire studies with relatively low response rates; rates below 33% were not uncommon. Unfortunately, mailings using targeted subject pools culled from data bases may be outdated or ineffectual given that targeted subjects may be relocated, unemployed, on vacation, or even deceased. Also, mailings may be perceived as less personal and less relevant to the potential subject than a more informed administration, and may therefore result in both lower response rates and less reliable responses. Also, those who do respond may be qualitatively different than those who elected not to participate. Higher response rates would likely improve overall ecological validity.

Generalizability

Another methodological criticism concerns the use of nurses as a relatively large proportion of the subject pool in the shiftworker stress literature. Generalizability from such studies to other shiftworking occupations presents several concerns, particularly when attempting to systematically test the effectiveness of different work-rest patterns. First, the nursing field is at present disproportionately represented by women. Even given recent advances in the cultural acceptance of and appreciation for male nurses, the occupation is still predominantly female and thus tenuous as a subject pool due to gender-based confounds.

Second, many studies of nurses report a relatively young population as compared to that seen across many diversified shiftworking occupations. Thus the literature focusing on nursing populations may less adequately capture age-related influences.

Third, the educational, socioeconomic, and ethnic backgrounds of nurses may at a general level be inconsistent with that of the shiftworking population at large, given that nurses must complete advanced training and may tend to have come from more privileged and/or less diversified backgrounds than seen in the general shiftworking population.

Fourth, nursing requirements often present an asymmetrical division of task assignments across shifts, since many patients are attempting to sleep during the night. Furthermore, there is typically less varied social interaction during the nightshift, given the general absence of patient visitors and relative paucity of doctors. Other industries, particularly manufacturing and continuous process operations, often attempt to run seamlessly from shift to shift with relatively few distinguishing features between the various timeslots (although training is more likely to occur on the nightshift, and supervisors do not always work during the night).

Sample Size

A number of studies also draw on inappropriately small sample sizes that may not be large enough to statistically support reported findings. For example, effects of outliers may be significant among studies with small sample sizes. More appropriately sized samples would enhance studies in two important ways. First, statistical integrity would be improved. Second, the ecological validity of the findings would increase.

Summary

Research using the demand-control-support framework would benefit from shiftwork intervention studies exploring the effects on jobs occupying different loci in the model. As a result, the effects of relevant job dimension characteristics on health and behavioral outcomes should tend to be more accurately estimated due to a better conceptualization and variation of exposure. Moreover, studies would benefit by better integrating self-rated, averaging, and independent methods of job stressor measurement to supplement each other and strengthen the validity of the investigation. As well, researchers should triangulate the stress construct through self-rated, physiological, and behavioral correlates. Finally, ill-health can be more fully identified through an analysis of medical diagnoses, health complaints, and functional impairment. As studies integrate greater combinations of Kristensen's (1995) 3S matrix, validity is likely to increase.

Additionally, studies would be strengthened through the use of longitudinal designs that incorporate follow-up measures after intervention. Moreover, a control or quasi-control group would enhance the study's value. As well, more informed data collection techniques should facilitate higher response rates, whereas more representative samples would improve generalizability. Finally, sample size should be sufficiently large enough to achieve statistical integrity and ecological validity.

Chapter 4: The Present Study

The chapter begins with an overview of the present study's purpose and rationale, describing the need for inquiry created by theoretical limitations of prior research investigating stress and coping processes in general and shiftwork stress in particular. Next, an extension of Karasek's (1979) demand-control paradigm is presented, integrating spouse/partner support in a demand-control-support conceptualization. The rationale for classifying the shift schedule as a significant demand stressor is then discussed, followed by the underpinnings of the present schedule selection process. Following this, the rationale for associated training on managing shiftwork stress is presented.

The present study's conceptual model is then presented, incorporating several previously suggested design improvements. More specifically, the section comments on how each of the relevant methodological criticisms (Heaney, 1995; Kasl, 1987; Kristensen, 1995; Totterdell and Folkard, 1990) discussed at the end of Chapter 3, as well as the theoretical considerations presented here in Chapter 4 (Barton, 1995; Heaney, 1995; Kogi, 1991; Kogi and diMartino, 1995; Lehrer, 1996; Smith and Barton, 1994) are addressed and integrated in the present longitudinal design.

The role of coping is then elaborated to provide a description of how coping functions as a mediator in the proposed conceptual model.

Following this, the roles of control and support operating as moderators of schedule demand are considered. The chapter concludes with a presentation of the aims of the present study followed by specific hypotheses.

PURPOSE AND RATIONALE

The purpose of the present study is to test a predictive, integrative mediational model of coping with shiftwork stress that addresses several emerging issues in the fields of stress research and shiftwork health and performance optimization (Barton, 1995; Cohen and Edwards, 1989; Cohen and McKay, 1984; Folkman and Lazarus, 1985; Heaney, 1995; Smith and Barton, 1994). The current study's conceptual model is designed to increase our understanding of how schedule demand as well as mediating coping processes moderated by support and control factors function to influence adjustment and performance, particularly in the context of a longitudinal intervention. The rationale for the model stems from prior limitations in stress and coping research (Folkman and Lazarus, 1985) including those studies employing shiftwork populations (Smith and Barton, 1994).

More specifically, the present study proposes to enrich our understanding of coping and of the effects of shiftwork stress on adjustment and operational performance as characterized by measures tapping psychological health, physical health, safety and productivity. As well, the model proposes to broaden and refine Karasek's (1979) demand-control paradigm to include spouse/partner support, and to examine the effects of interventions aimed at attenuating maladaptive aspects of demand, control, and support variables.

THEORETICAL CONSIDERATIONS

Several theoretical issues highlighted in the literature review (Barton, 1995; Bosch, 1990; Cohen and Edwards, 1989; Cohen and McKay, 1984; Corlett et al., 1988; Curson, 1986; Folkard, 1992; Folkman and Lazarus, 1985; Heaney, 1995; Kogi, 1991; Kogi, 1995; Kogi and diMartino, 1995; Lehrer, 1996; Smith and Barton, 1994; Terry, 1991; Thoits, 1985; Wedderburn, 1989) are now addressed to provide the underlying rationale for the proposed conceptual model introduced later in this chapter. First, a broadening of the current coping taxonomy is supported to better understand and capture measures of coping efficacy. Next, Karasek's demand-control paradigm is broadened and refined to integrate support resources both at and away from the workplace. Then, work-rest scheduling demands are conceptualized as critical components of shiftwork stress processes that affect coping and adjustment outcomes.

Coping Research – What's Missing?

Several personal and social resources have been identified as having predictive value in determining coping responses to stress (Cohen and McKay, 1984; Cohen and Edwards, 1989; Thoits, 1985). Nonetheless, very little is known regarding the breadth of the coping response, or of coping breadth as a predictor of adjustment (Carver et al., 1993). More specifically, does breadth of coping repertoire, subsumed under the rubric of coping flexibility, relate to stress and coping processes? That is, does the number and selection of possible coping responses in one's coping toolbox predictively influence one's ability to cope with a stressor? If so, is breadth of coping in turn influenced by personality variables (Cohen and McKay, 1984; Cohen and Edwards, 1989; Thoits, 1985) and situation variables (Eilers and Nachreiner, 1990; Folkman et al., 1986; McRae, 1984)? These questions have yet to be adequately addressed in stress and coping research (Carver et al., 1993; Carver and Scheier, 1994; Folkman and Lazarus, 1985).

Applying previous research, the question emerges as to whether there is an underlying pattern of adaptive coping stability (Carver and Scheier, 1994; Folkman and Lazarus, 1985; Vitaliano, DeWolfe, Maiuro, Russo, and Katon, 1990) that ties together overt patterns of apparent transition in coping styles. That is, while certain coping strategies evolve and change, does one's ability over time to sample and remain engaged in an array of ancillary strategies aid in the coping process? Adaptive coping may in fact be less reliant on invariant reactions to stressors but rather on one's ability to adaptively transition among a wide range of responses as required by the dynamics of the stressor (Folkman and Lazarus, 1985).

Implications of past research (Carver and Scheier, 1994; Folkman and Lazarus, 1985; Vitaliano, DeWolfe, Maiuro, Russo, and Katon, 1990) lead logically to considerations of a flexible, optimally engaged repertoire of dynamic coping responses to better meet the adaptive needs of the individual in responding to change both within and between situations. For example, Folkman and Lazarus (1985) acknowledged that we need to explore individual differences in the <u>stability</u> and <u>variability</u> of coping. They further suggested that these differences may be an important factor in determining both short and long-term outcomes following stressful encounters.

Moreover, the understanding of how contextual factors moderate coping's role in stress processes needs to be broadened (Coyne et al., 1981; Folkman et al., 1986; Mattlin et al., 1990; McRae, 1984). Given that the selection and intensity of coping responses to a stressor are neither universal nor constrained, it seems important to investigate factors influencing coping's malleability (Folkman and Lazarus, 1984). One purpose of this study is to address these issues by examining underlying patterns of coping and related influences on adjustment. It seems likely that individuals who tap a broader range of adaptive coping strategies generally adapt to stress better than those who demonstrate a relatively restricted range of response (Carver and Scheier, 1994; Folkman and Lazarus, 1985; Vitaliano, DeWolfe, Maiuro, Russo, and Katon, 1990). It also seems likely that <u>locus of control</u> (Andersen, 1977; Carver et al., 1989;

Fleishman, 1984; Hockey, 1986; Parkes, 1984; Spector, 1982; Terry, 1991) and support resources (Cohen and Wills, 1985; Cohen and McKay, 1984; Dalbokova et al., 1995; House, Landis, and Umberson, 1988) are related to breadth of coping repertoire.

Broadened Coping Taxonomy

If breadth of coping repertoire is characterized in part by a range of available coping strategies (Carver, Scheier, and Weintraub, 1989; Folkman and Lazarus, 1984) it seems important to broaden the taxonomy of coping choices to include all potentially distinguishing responses. Current taxonomies readily distinguish between approach and avoidance coping (Compas, Malcarne, and Fondacaro, 1988; Roth and Cohen, 1986; Vitaliano, Maiuro, and Russo, 1987) but fail to integrate into their theoretical framework a critical third strategy termed auxiliary coping in the present study. This additional strategy is now conceptualized as a further partitioning of Carver's coping subscales (Carver, Scheier, and Weintraub, 1989) that goes beyond traditional approach and avoidance coping.

Auxiliary Coping

Applying theoretical concepts from prior research (Carver and Scheier, 1994; Folkman and Lazarus, 1985; Kessler, Price, and Wortman, 1985; Lazarus and Folkman, 1984; Vitaliano, DeWolfe, Maiuro, Russo, and Katon, 1990), auxiliary coping has only recently been systematically studied as part of a broadened theoretical framework for understanding coping processes (see Lehrer, 1996). Operationally, auxiliary coping is defined as strategies that are inherently neither approach nor avoidant in nature. More specifically, auxiliary coping strategies (such as humor, religion, and acceptance) involve efforts to continue adaptive functioning without directly confronting the stressor. At the same time, these strategies do not involve a denial of the stressor as is characteristic of avoidance coping (Roth and Cohen, 1986).

Consistent with prior theoretical postulations (Carver and Scheier, 1994; Folkman and Lazarus, 1985), auxiliary coping may serve as a stabilizing factor before making a transition to approach-oriented coping efforts. By organizing relevant coping subscales according to approach, avoidant, or auxiliary features, the effects of manipulations on coping processes can be isolated with a greater degree of specificity. Thus, broadening the coping domain to include an auxiliary coping strategy may inform understanding of stress and coping processes in general.

In summary, although studies of coping strategies have traditionally centered around active, approach oriented, problem-solving efforts and emotion-based, avoidance strategies, research on coping has not adequately investigated coping flexibility (Folkman and Lazarus, 1985) and auxiliary coping (Lehrer, 1996) as predictive indices of coping efficacy.

Karasek's Demand-Control Model Confined

Another theoretical criticism associated with prior research on stress and coping processes relates to Karasek's (1979) original demand-control paradigm used to explore relationships between imposed stressors and resulting job strain. As Kristensen (1995) pointed out, although the association between a health measure (e.g., CVD) and high strain is demonstrable, a satisfactory explanation is more difficult. For example, adverse levels of demand, control, and support variables may enhance the risk of heart disease through behavioral (exercise, alcohol, sleeping patterns) and/or physiological changes (blood pressure, obesity, stress hormones), but such causal pathways are difficult to study empirically given that several mechanisms can be active simultaneously (Kristensen, 1995; Schnall and Landsbergis, 1994).

Moreover, such factors are influenced by variables occurring <u>outside</u> the work environment (Beermann and Nachreiner, 1990; Beermann and Nachreiner, 1995; Heaney, 1995). Therefore, it seems unlikely that either the demand-control or the demand-control-work support conceptualizations, as first described in Karasek's (1979) model and subsequent revisions (see Astrand et al., 1989; Falk et al., 1992; Johnson and Hall, 1988; Johnson and Hall, 1989), adequately capture the psychosocial environment contributing to job strain; that is, the model may tolerate meaningful refinement without sacrificing parsimony.

Interestingly, lacking in the revised demand-control-support model is the inclusion of <u>social support away from the workplace</u>; that is, support removed from the work environment, such as support garnered from family and friends not working for the individual's employer (Cohen and McKay, 1984). Consistent with the view that greater levels of family support were more predictive of active coping strategies and efforts to seek emotional support when under stress (see Holahan and Moos, 1990, 1991), the integration of such a measure into the model could provide a composite index of support that both refines and broadens the model's validity by better capturing variables relating to psychological and physical adjustment as well as performance. More specifically, extending Karasek's (1979) original demand-control model to integrate a measure of spouse/partner support may accommodate a demand-control-support framework that further informs coping strategies and subsequent adjustment outcomes.

Furthermore, the model neglects individual differences concerning the appraisal of strain (Lazarus and Folkman, 1984) as well as the susceptibility to strain and coping abilities when under strain (Kristensen, 1995). Building upon earlier theoretical foundations (Barton, 1995; Karasek, 1979; Lazarus and Folkman, 1984; Schnall and Landsbergis, 1994; Theorell and Karasek, 1990; Theorell and Karasek, 1996), it seems likely that a conceptual model integrating measures of such individual differences within a demand-control-support framework would better inform the effects of stressors on strain and subsequent adjustment.

Another criticism of the model is that it disregards the power structure at the worksite (Kristensen, 1995, Lehrer 1995). Both perceived and actual job-related control likely include not just the freedom to make decisions while on the factory floor, but also the power to influence working conditions such as the duration and pattern of duty rosters (Barton et al., 1995; Hornberger and Knauth, 1995). For example, the ability to actively participate in the selection of one's own work schedule (Heaney, 1995; Smith and Barton, 1994; Terry, 1991; Lehrer, 1993; Wallace and Greenwood, 1995) may add an important element of control that can affect both health and behavioral outcomes. Consequently, a broadened model may strengthen Karasek's original conceptualization by considering organizational elements of decision making (control) beyond on-the-job task analyses. Such a formulation may enhance both practical and theoretical utility.

Work Schedule as Stress Variable

Despite broad consensus that shiftwork can contribute to a range of deleterious effects on health and well-being (Barton et al., 1995; Costa, et al., 1995; Folkard and Monk, 1985; Scott, 1990; Smith and Folkard, 1994; Torsvall et al., 1981; Waterhouse et al., 1992), there exists within the shiftwork domain the potential for considerable differences in demand among the various shift schedules in operation and even within identical shift schedules, given unique site-specific and/or job-specific parameters (Akerstedt, 1997; Barton, 1995; Folkard, 1990; Hornberger and Knauth, 1995; Monk, 1986). For example, a 12-hour shift with little heavy lifting and a 10 minute commute may be considerably less demanding than an identical shift duration involving heavy lifting and a one to two hour drive.

Moreover, individual employee and family preferences can contribute significantly to considerations of optimal schedule fit.

Yet, when an organization considers a schedule change, what often receives substantial consideration is a management driven desire for organizational parsimony; that is, there can exist a well-intended yet misinformed perception that having only one schedule can "tighten the reigns" to produce a more cohesive, productive team (CTI, 1996). Moreover, a unidimensional core working time arrangement is typically easier to manage, track, and modify, particularly concerning human resource issues such as payroll and overtime policies. The immediate yet illusory economy of such a homogeneous scheduling environment appears even more viable when further considering potential advantages of streamlined policies for handling vacations, shift differentials, sick days, personal days, holidays, plant shut downs, maintenance crews, relief crews, training, and a host of other personnel challenges that accompany running many round-the-clock operations (Lehrer et al., 1993).

However, a "one size fits all" schedule is often neither the best short nor long-term solution for either labor or management, particularly if it contributes to impairments in physical and psychological health, alertness, morale, safety, and performance. Instead, certain job classifications are likely best managed through job-specific scheduling considerations (Akerstedt, 1997; Barton, 1995; Folkard, 1990; Hornberger and Knauth, 1995; Monk, 1986). Furthermore, research supports the view that the control one has in such a decision may significantly influence one's biopsychosocial adjustment both on and off the job (Terry, 1991; Smith and Barton, 1994; Heaney, 1995). Thus a consideration of optimizing employee shift schedules to attenuate existing levels of biopsychosocial stress would likely benefit from a process that maximizes employee participation and control (Karasek, 1979; Theorell and Karasek, 1990, 1996).

Scheduling Assessment and Change: The Intervention Process

Kogi (1991) pointed out that the introduction of an effective working-time reorganization is a local process, whereby a functional solution considers the numerous factors relating to job demands and working life in the local context. Thus support for such a reorganization benefits through the application of realistic solutions adapted to local conditions. Conflicting interests both within and among divisions of labor, management, and regulators are common in any organization; nonetheless, collective agreements are possible when crafted within a framework of long-term working time solutions (Kogi and diMartino, 1995; Spurgeon, 2003).

Organizational flexibility greatly enhances a corporation's ability to achieve such goals; however, many companies adhere to misguided policy that provides less than optimal flexibility regarding working time reorganization processes. Consequently, there exists a need for studies exploring the efficacy of organizational processes that demonstrate flexibility in allowing employees to participate in selecting appropriate work schedules according to site and job specific criteria (Heaney, 1995; Hornberger and Knauth, 1995; Smith and Barton, 1994; Terry, 1991). As well, such flexibility should adequately reflect both the needs of employees and the findings of relevant studies (Bosch, 1990; Corlett et al., 1988; Curson, 1986; Kogi, 1991). Moreover, such flexibility should incorporate allowances for various forms of modification and rearrangement of working time agreements (Kogi, 1995).

This is important, since the literature suggests that there is no "ideal" system (Barton, et al., 1995); rather, determining the ideal schedule for a particular employee group is a site-specific process. Broadly however, some general tenets appear to hold true. For example, it is generally agreed upon in the literature that certain types of shift schedules are likely to be more disruptive than others, thus having a greater deleterious effect on the workers concerned (Barton et al., 1995). In fact, much research has aimed to identify those systems or features of systems which may be healthier and safer than others (Wedderburn, 2000).

It is therefore not surprising, given the commonality of operations across and within organizations providing similar services, that there exists an intuitive albeit misguided temptation to ascribe particular interventions to particular segments of industry, or to an entire company, regardless of key factors such as location, demographics, or job classification (CTI, 1996). With respect to this practice, Daniels and Guppy

(1995) showed that even within the same job classification there may be significant differences among distinct organizational environments.

Thus, Folkard (1992) has argued the need to examine the severity of shiftwork-related disturbances in comparable groups of shiftworkers on shift schedules that differ systematically from one another. In this way researchers will be better able to isolate the relative contributions of various features. More specifically, some scheduling features of importance include the sequencing, timing, and duration of the individual schedules, as previously highlighted (Barton, 1995; Eilers and Nachreiner, 1990; Folkard, 1990; Hornberger and Knauth, 1995; Monk, 1986). Furthermore, the work environment, including the type of work, title and position, and the degree of subjective workload experienced on the different shifts (Barton et al., 1995) serves as a potential moderator of health and safety outcomes.

Interestingly, assessing the value of a shift schedule change, such as in transitioning from an 8-hour to a 12-hour schedule, appears to be as much an evaluation of the implementation process as of the restructuring of the work cycle. (Wallace and Greenwood, 1995). Some critical implementation components that Wallace and Greenwood note include: an analysis of organizational needs, shiftwork education of both management and employees, examples of remuneration, and ongoing consultation with management, union representatives if applicable, and the workforce. Moreover, given the significant effects to family and social life, the literature suggests a need for informed joint planning of shift schedules by social partners (Thurman, 1990; Kogi, 1991, Kogi and Thurman, 1993).

Kogi and diMartino (1995) further suggest that such a process include sufficient technical input (Lehrer et al., 1993) regarding both constraints and options. They propose that such a process benefits from the support of individuals with expertise in facilitating "a well-informed, participatory process of change (that) will need to be developed for promoting the effective improvement of shiftworking conditions."

Appropriate procedures for the evaluation of change are also critical (Kristensen, 1995). An appraisal of workers prior to intervention provides baseline measurements that can then be repeated after the reorganization process has been implemented for a reasonable period to allow for the "honeymoon" effect to dissipate. These pre- and post-change measures are necessary to control for individual differences in shiftwork tolerance.

Moreover, multiple outcome measures, such as those previously described in Kristensen's (1995) 3S-matrix, are appropriate to better gauge the effectiveness of intervention. Wallace and Greenwood (1995) note that self-ratings of work load, effort, performance, and frustration are applicable, as are organizational records of absences, illnesses, accidents, lost time injuries, and production figures, all of which can be used in a pre- and post-implementation assessment. Additionally, consistent within an established empirical framework (Cohen and Syme, 1985; Cronkite and

Moos, 1984; Holahan and Moos, 1987; Holahan and Moos, 1991) pre- and post-implementation assessment of effects on social and family life would likely further inform the efficacy of coping responses.

Although considerable focus has been given to the design of stress interventions in the workplace and to evaluations of their effectiveness (Ivancevich and Matteson, 1987; Murphy, 1988; Newman and Beehr, 1979), little attention has been focused on practical issues of implementation; that is, clinical, industrial, and organizational psychologists have largely failed to address the issues of acceptability among those employees who receive stress management services (West and Reynolds, 1995). Moreover, care needs to be taken to ensure that senior management supports, optimally establishes, and appropriately maintains such interventions.

Furthermore, West and Reynolds (1995) note that perceptions of the confidentiality of the service are critical to its success. Because information travels quickly and at times incorrectly in organizational settings, both the perception and reality of confidentiality needs to be clearly demonstrated. This is especially true when survey instruments gather personal information that the employee wishes to keep separate from his or her professional relationship with the employer.

Whereas organizational involvement may benefit from involving "insiders" who possess a greater level of understanding of the unique work environment not available to "outsiders", such involvement may in fact be perceived as a threat to confidentiality (Moran and Colless, 1995).

Consequently survey respondent rate may be significantly lower than desired under such circumstances. Anecdotally, maintenance of confidentiality and trust have been instrumental in facilitating favorable results in work-related stress management interventions, and are generally best achieved when objective third party support and technical expertise facilitates the change process with the aid of internal resources functioning in the context of a joint labor/management task team, moderated by the objective third party.

Specifically, Kogi (1995) recommends five fundamental steps for designing flexible scheduling interventions aimed at attenuating shiftwork-related stressors: 1) group study of worker preferences and organizational needs, 2) joint planning to find feasible options after agreeing on the level of flexibility, 3) consensus building via dialogue and feedback, 4) testing and modification, and 5) joint implementation, typically in a progressive manner. This multidimensional change process focuses on implications for worker health and safety as well as the productive organization of work.

Such a planning and implementation process is further facilitated by support measures that can guide both the organization and the workforce in addressing the complexity of social and technical issues surrounding the reorganization of working time (Cressey and diMartino, 1989; Dy, 1990; ILO, 1990; Wedderburn, 1989). Specifically, schedule change support should reinforce an on-going local process such that working life and operational performance issues are addressed in the local context (Kogi, 1995).

Kogi further argues that particularly salient to such a scheduling change process are the presentation of available options with relevant information on advantages and disadvantages, as well as training and group consultation. Relatively few schedule changes have undergone such a process; thus there exists a need to study such an effort in detail to explore the efficacy of this intervention.

Interestingly, Barrett (1995) noted that it is also likely that the efficacy of prevention measures will be enhanced through various regulatory systems worldwide as occupational safety legislation is sufficiently developed to impose meaningful liability on those who expose shiftworkers to unacceptably stressful conditions. Thus, systematic research in real world environments serves to provide regulatory agencies with the needed tools to effectively craft policy (ILO, 1990).

In summary, a better understanding of variables influencing adverse health, safety, and performance outcomes can inform countermeasure development and implementation by employers, employees, and regulatory agencies, which can in turn attenuate the occurrence of such outcomes.

Shiftworker Lifestyle Training

Barrett (1995) argues that employers should increase efforts to actively mitigate harmful effects of experiences inherent in performing work duties. More specifically, Barrett highlights an employer's duty to provide adequate "information, instruction, training and supervision." Such provisions can foster proactive employee responsibility regarding personal care and safety (Heaney, 1995), thus enhancing the efficacy of related interventions aimed at mitigating the effects of shiftwork stress.

Although stress management programs for critical incident stress (CIS) are widely established (Moran and Colless, 1995), Sims (1995) noted that the workplace is well suited for the occurrence of everyday stressors as well. Less readily available are efficacious interventions to address both the acute and chronic stressors of shiftwork, despite a substantial research literature identifying a diverse range of disturbances experienced by individuals as a result of working shifts (Barton et al., 1995). These range from acute disturbances of circadian rhythms to disrupted family and social life as well as chronic impairment of both mental and physical health (US Congress OTA, 1991; Waterhouse et al., 1992).

Consistent with prior theoretical recommendations (Barton, 1995; Barrett, 1995; Cressey and diMartino, 1989; Dy, 1990; ILO, 1990; Wedderburn, 1989), it seems likely that the effects of shiftwork stress can be attenuated by implementing countermeasures that afford better recuperation within and between shifts. Such intervention could potentially optimize shiftworker health, safety, and productivity, and thus mitigate the personal, environmental, and economic costs of shiftwork stress.

Consequently there exists a need to investigate the combined and singular effects of optimally designed shift schedules (Akerstedt, 1997; Barton, 1995; Folkard, 90; Hornberger and Knauth, 1995; Monk, 1986) in conjunction with relevant shiftworker lifestyle training, (Barrett, 1995; Folkard et al., 1978; Kundi et al., 1981; Nicholson and Marks, 1983; Waterhouse, 1992), since job satisfaction and attitude towards one's work schedule affect not only motivation and absenteeism, but also adjustment and health (Kundi et al., 1981; Folkard et al., 1978).

Interestingly, a number of studies investigating only changes in shift schedules have found no-difference results in health disturbances for periods of 1 year or less (Akerstedt and Torsvall, 1980; Knauth and Kiesswetter, 1987), although changes in sleep disturbances and fatigue were seen. Perhaps longer periods are required to see significant health changes, or perhaps the schedule change process did not optimally involve the employees, thereby diminishing levels of personal control and associated influences on coping efficacy. Alternatively, consistent with prior theoretical implications (Nicholson and Marks, 1983; Waterhouse, 1992), a synergism may exist between scheduling changes and related training that enables significant psychological and physical health benefits to emerge more rapidly.

For example, although Maddi and Kobasa (1984) conclude that hardiness is a personality characteristic derived from a healthy childhood, they further suggest that people can be trained to be more hardy. Thus if a relationship exists between a component of hardiness (e.g., internal locus of control) and positive adjustment to shiftwork, then intervention aimed at improving hardiness appears worthwhile. Moreover, such an intervention would likely benefit from looking at the shiftworker's total lifestyle, as opposed to just their job performance (Waterhouse et al., 1992).

Furthermore, Kogi and diMartino (1995) propose that locally adapted training using participatory methods is useful in facilitating any schedule change process. They further suggest that training should have as goals: 1) well-informed understanding of shift work's effects on family and social life, health, and performance, 2) ways of arriving at feasible options of work schedules that can meet both workers' preferences and business requirements, and 3) ways of coping with shiftwork.

The latter recommendation highlights the need for practical training solutions (Nicholson and Marks, 1983; Heslegrave, 1999). For example, although sleep disturbance among shiftworkers has been extensively documented (Frese and Harwich, 1984; Kogi, 1982), little research has investigated ways to minimize such sleep disturbances (Greenwood et al., 1995). This is changing, however, since research leading to improvements in night workers' sleep will likely help workers feel better psychologically and physically, as well as contribute to decreased accident rates and improved work performance (Greenwood et al., 1995).

Interestingly, Nicholson and Marks (1983) proposed practical sleep hygiene recommendations including a number of proactive strategies such as attenuating time-in-bed worry, maintaining regular sleep times and an appropriate sleep environment, participating in regular exercise, eating regular, balanced meals, avoiding caffeine and alcohol before sleep, and utilizing the bedroom only for sleep and sexual activity.

Unfortunately, a number of behaviors that are contraindicated by the above sleep hygiene recommendations are utilized by nighttime workers in an effort to maintain alertness, such as excessive caffeine intake (Walsh et al., 1990). Also, family and social demands can conflict with a night worker's maintenance of a number of sleep hygiene behaviors (Walker, 1985). Thus there exists a need for education so that shiftworkers can better understand and manage their demanding schedules while optimizing safety and health (Waterhouse, 1992).

PROPOSED CONCEPTUAL MODEL

Figure 2 illustrates the present study's proposed longitudinal model of predictive relationships between a set of biopsychosocial and work-related variables at follow-up twelve months after baseline measurement in an intervention process. Objective OSHA group safety data by work classification is also examined for a period of twelve months prior to and twenty-four months post scheduling and training initiatives.

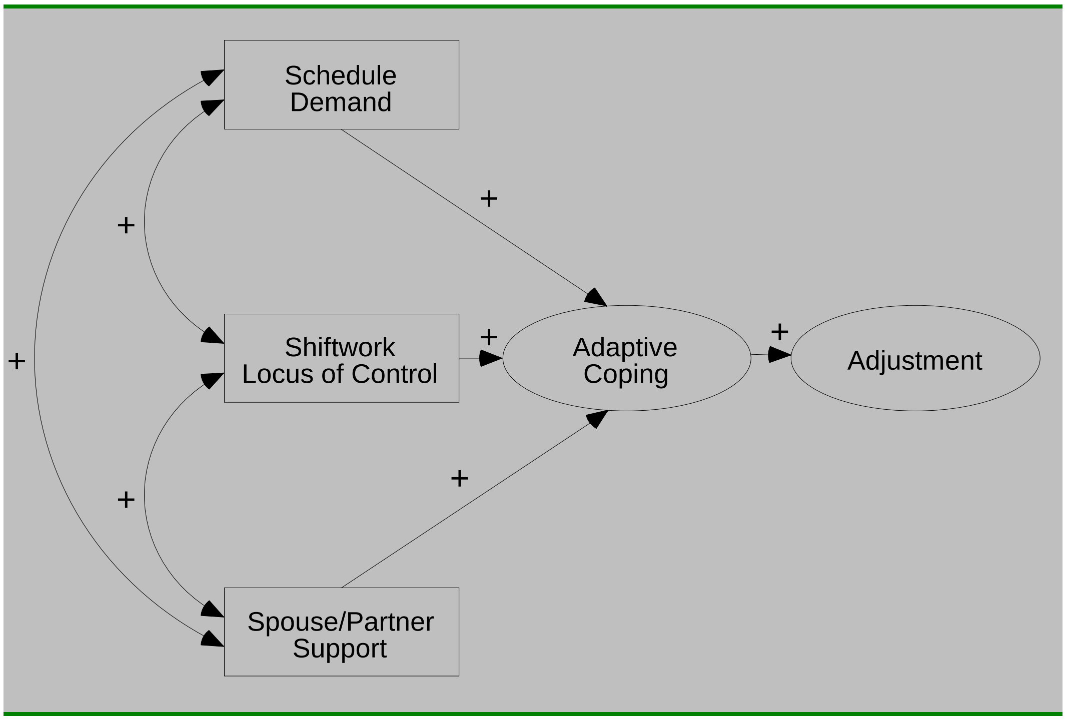


Figure 2. Longitudinal path-analytic model of predictive relationships. (Latent constructs are shown in ellipses). The model is examined controlling for the effects of adjustment at baseline.

Figure 3 further illustrates the conceptual underpinnings of the present model and represents hypothesized structural equation and measurement models. Testing of the integrative model is designed to address several methodological criticisms (Goodwin, 1995; Heaney, 1995; Kasl, 1987; Kristensen, 1995; Winkleby et al., 1988; Netterstrom and Suadicani, 1993; Totterdell, 1995; Totterdell and Folkard, 1990) of shiftwork stress research previously discussed at the end of chapter 3. These criticisms address issues concerning the intervention, variation of exposure

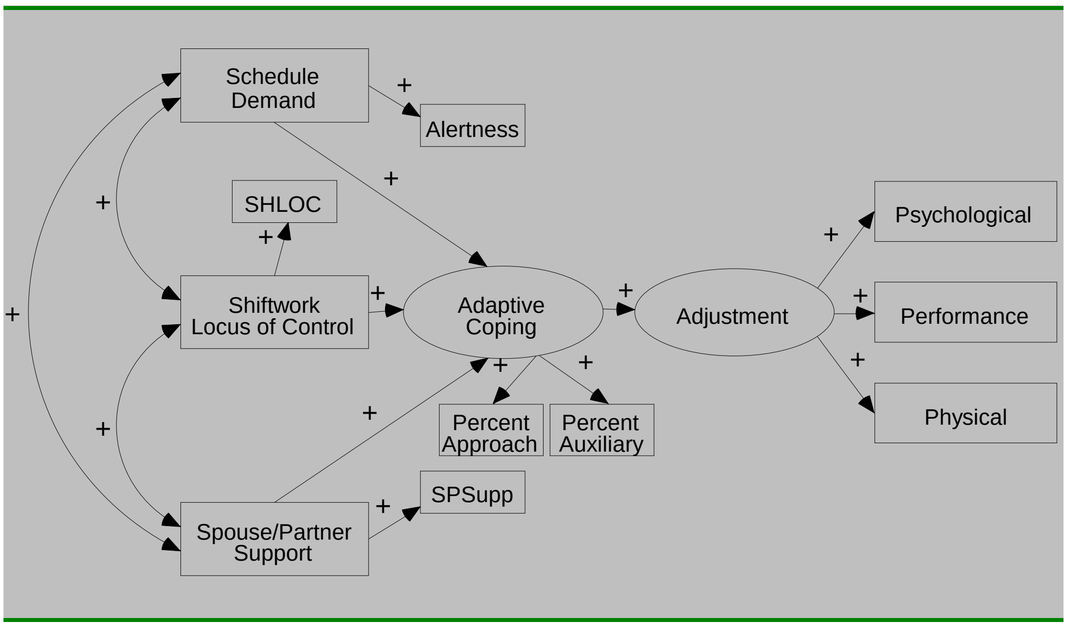


Figure 3. Hypothesized structural equation and measurement models of predictive relationships between an initial intervention process and a set of biopsychosocial and work related variables at follow-up. (Latent constructs are shown in ellipses and observed variables are shown in rectangles). The model is tested controlling for adjustment at baseline.

and method of measurement, longitudinal design, control and quasi-control groups, and ecological validity. Furthermore, the present model incorporates new theoretical concepts that build on the established framework (Barton, 1995; Bosch, 1990; Cohen and Edwards, 1989; Cohen and McKay, 1984; Corlett et al., 1988; Curson, 1986; Folkard, 1992; Folkman and Lazarus, 1985; Heaney, 1995; Karasek, 1979; Kogi, 1991; Kogi, 1995; Kogi and diMartino, 1995; Smith and Barton, 1994; Terry, 1991; Thoits, 1985; Wedderburn, 1989) presented at the beginning of Chapter 4. These new concepts include formulations to expand Karasek's (1979) demand-control model, broaden and refine current coping taxonomy, and conceptualize the shift schedule as a significant demand variable. These methodological and theoretical refinements are now integrated into the current longitudinal design.

Methodological Improvements

Intervention

Intervention studies are disproportionately underrepresented in workplace strain research (Kristensen, 1995). Therefore the current study proposes to not only test an integrative model of coping with shiftwork stress, but also to test for singular and combined effects of a multimodal intervention in predicting subsequent adjustment twelve months after baseline measurement, controlling for adjustment at baseline. Consequently, the present intervention study will explore relationships between specific changes in model parameters and subsequent changes in adjustment.

Moreover, the study seeks to rigorously examine the mechanisms underscoring the nature of shiftwork as a stressor affecting psychological health (Bohle and Tilley, 1993; Cole, 1996; Costa, 1993; Tasto, et al., 1978; Wynne et al., 1986), physical health (Akerstedt, 1987; Barton et al., 1995; Costa, 1993; Moore-Ede and Richardson, 1985; Theorell et al., 1988), and both safety (Folkard and Monk, 1985; Scott, 1990; Smith and Folkard, 1994) and productivity-related indices of operational performance. Furthermore, the present intervention proposes to inform efforts at attenuating and/or coping with identified stressors.

Variation of Exposure

As Kristensen (1995) observed, too many studies have been based on homogeneous "representative" samples without specific job descriptions to distinguish subject populations, making efforts to elucidate possible causal pathways tenuous. Data collected in the present integrative design, however, affords the opportunity to examine the effects of differentiated and defined exposures to shiftwork stress (Akerstedt, 1997; Barton, 1995; Folkard, 90; Hornberger and Knauth, 1995) as operationalized according to shift schedule and job function. Furthermore, the presence of independent job descriptions allows for a comparison of such descriptions with ratings from the workers themselves. Thus there exists in the present study adequate variation of exposure to statistically investigate possible causal pathways in the proposed conceptual model (Kristensen, 1995).

Methods of Measurement

Kristensen (1995) organized an effective 3S-matrix to more accurately measure job dimension stressors, stress levels, and ill-health (sickness), yet few studies in the literature appear to utilize this informed approach. The present study proposes to optimally incorporate this methodology within the operating boundaries of the investigation, and in so doing more accurately measure observed variables and latent constructs.

Measures of Job Dimension Stressors

The present study aims to attenuate measurement bias as described in Chapter 3 by Kristensen (1995) through a longitudinal study crafted to integrate the use of both the self-rated method, in which each employee responds to questions concerning job demand, control, and support, and an average values method, in which all employees working the same schedule and/or job function, for example, contribute to a group average OSHA safety incident rate. More specifically, behavioral outcome measures including accidents and injuries are gathered in the present study as group statistics by job classification and by schedule, allowing for data to be composited in a number of meaningful ways.

As well, job dimension characteristics are gathered independently of the employees undergoing exposure, including an analysis of job responsibilities and stressors obtained through management interviews and observations as well as findings presented in the literature. Thus by considering self rated and averaging techniques in conjunction, where appropriate, with behavioral outcomes and independent measures (Kasl, 1987; Kristensen, 1995; Netterstrom and Suadicani, 1993; Winkleby et al., 1988), the present study proposes to better facilitate understanding of the underlying mechanics of shiftwork stress and coping processes.

Measures of Stress Levels

The present study also uses multiple methods for measuring stress levels (Kasl, 1987; Kristensen, 1995; Netterstrom and Suadicani, 1993; Winkleby et al., 1988), including self-rated correlates of stress relating to family and social life as well as mental well-being In addition, physiological indicators are formulated from employee reports of cardiovascular and digestive symptomatology. As well, behavioral correlates of stress including accident rates and related lost workdays provide objective data. (Barton, et al., 1995).

Measures of Ill-Health

The present study further incorporates multiple measures as suggested by Kristensen (1995) for assessing levels of ill-health. First, ill-health at the level of disease is inferred via worker recall of medical diagnoses. Second, ill-health is inferred as a function of worker complaints established via self-report. Third, ill-health is inferred via impairments to employee functional ability to perform job duties.

Longitudinal Design

Totterdell et al. (1995) noted that longitudinal momentary self-reports, as compared to cross-sectional designs, were less susceptible to stereotyped responding and also better inform an assessment of causality. Thus, the present 12-month time-lag study proposes to attenuate stereotyped responding and better inform causality while still being able to capture meaningful relationships among variables in the model. As well, objective safety data was analyzed for periods of 12 months pre- and 24 months post-implementation of scheduling and training interventions to more accurately assess safety and related performance indicators over time.

Control or Quasi-Control Group

Many longitudinal designs lack any type of control group (Totterdell and Folkard, 1990). The present study proposes to address this concern by incorporating quasi-control groups into the experimental design, making it less difficult to distinguish confounding effects from changes resulting due to variations in model parameters. In the present design, each group of employees belonging to one of eight functionally distinct job categories had the opportunity to change schedules or to remain on the current schedule as a group. Furthermore, within each group, regardless of whether or not there was a schedule change, each individual was able to decide whether or not to participate in training on coping with shiftwork stress.

Thus, although groups and individuals were self-selected with respect to scheduling and training interventions (i.e., assignment to groups is not random), the quasi-control design of the present study allows for an informed investigation of causality by creating distinct levels of experimental manipulation, with some groups remaining on the same schedule. This improved quasi-control design has been absent in a number of other scheduling interventions where all subjects received the same experimental manipulation (Totterdell and Folkard, 1990).

Ecological Validity

The present study aims to mitigate the ecological shortcomings of previous designs by addressing issues of response rate, generalizability, and sample size.

Response Rate

To avoid unacceptably low response rates generated from mailings and other less reliable techniques, the present study aimed to optimize rates of response in several ways. First, the purpose and process of the survey administration in relationship to scheduling and training interventions was communicated in advance to potential participants to gain support and interest through a systematic, coordinated effort involving a videotaped presentation aired over several days at the facility's main employee entrance as well as in the break rooms, group and individual employee information sessions, educational meetings with key management and union leadership, mailings, and postings at key plant locations.

Second, the initial survey was administered in a spacious, convenient setting removed from the employee's actual work area to diminish distractions and encourage more comfortable participation in a relaxed and properly prepared survey environment.

Third, group administration of individually completed initial surveys was preceded immediately by a detailed reiteration of 1) the survey process, 2) the importance of the survey in ultimately determining schedule choices, 3) the value of the data in investigating issues relating to health, well-being, and safety, and 4) the maintenance of anonymity throughout the entire process.

Fourth, survey administration was structured to enhance the accessibility of all potential subjects. That is, initial survey administration was conducted following each of the shifts for three consecutive days (nine consecutive shifts) so that the maximum number of employees would have the opportunity to participate in the survey without having to come in on a day off. As well, the present author administered instructions and proctered each initial survey session to optimize consistency during the administration process.

Generalizability

Another methodological criticism of prior research concerns the disproportionate use of nurses as subjects in the shiftworker stress literature. As was previously discussed in Chapter 3, generalizability from such studies to other shiftworking occupations presents several concerns. The present study therefore focuses on a population that shows heterogeneous representation along several important dimensions including gender, age, and ethnicity.

As well, the educational level of the subject population in the present study is more representative of shiftworkers as a whole as compared to the relatively higher level of education evidenced among nursing populations. Moreover, the eight functional tasks in the present study's manufacturing environment show far less disparity between shift duties than is often seen in fields such as nursing, for example. Thus the present study's subject population better represents shiftworking operations in general, affording greater levels of ecological validity.

Sample Size

A number of studies have employed inappropriately small sample sizes not large enough to statistically support reported findings. The present study, however, employs a relatively large and diverse sample overall and therefore can explore certain analyses with appropriate confidence in both the findings and their applicability to shiftwork operations at large. To further aid in drawing conclusions from analyses conducted in the present study, a power analysis was performed for samples tested to gauge the likelihood of finding effects of interest.

Theoretical Refinements

Several theoretical issues previously discussed are now integrated in the current study's proposed conceptual model. These include refining traditional coping taxonomy (Carver, Scheier, and Weintraub, 1989; Carver et a., 1993; Cohen and Edwards, 1989; Cohen and McKay, 1984; Folkman and Lazarus, 1985; Lehrer, 1996), broadening Karasek's demand-control model (Beermann and Nachreiner, 1990; Barton, 1995; Heaney, 1995; Karasek, 1979; Schnall and Landsbergis, 1994; Theorell and Karasek, 1996), and conceptualizing work-rest scheduling demands as a significant factor in predicting health and performance outcomes (Barton, 1995; Bosch, 1990; Folkard, 1992; Heaney, 1995; Kogi, 1991; Kogi, 1995; Kogi and diMartino, 1995; Smith and Barton, 1994; Terry, 1991; Thoits, 1985; Wedderburn, 1989).

Broadened Coping Taxonomy

Folkman and Lazarus (1985) proposed that informed research is needed to explore individual differences in the stability and variability of coping, as such differences may be an important factor in determining both short and long-term outcomes following stressful encounters. Indeed, individuals who can tap a broader range of adaptive coping strategies and display more <u>flexibility of response</u> may adapt to stress better than those with a relatively restricted range of response.

Yet, the ability to measure such flexibility may be compromised in traditional conceptualizations (see Carver and Scheier, 1994; Folkman and Lazarus, 1985). Although current taxonomies readily distinguish between approach and avoidance coping (Roth and Cohen, 1986), they fail to integrate into their theoretical framework a critical third strategy termed auxiliary coping (Lehrer, 1996), described earlier in the chapter and operationalized in the present study by partitioning Carver's coping subscales (see Carver, Scheier, and Weintraub, 1989) to accommodate a third coping domain termed auxiliary coping, thereby extending beyond traditional approach and avoidance coping response sets.

Karasek's Demand-Control Model Expanded to Include Spouse/Partner Support

Interpretation of a large body of research (e.g., Barton, 1995; Karasek, 1979; Lazarus and Folkman, 1984; Schnall and Landsbergis, 1994; Theorell and Karasek, 1990; Theorell and Karasek, 1996), suggests that it is unlikely that either the demand-control conceptualizations described in Karasek's (1979) model or subsequent demand-control-work support revisions (Astrand et al., 1989; Falk et al., 1992; Johnson and Hall, 1988; Johnson and Hall, 1989) adequately capture the psychosocial environment contributing to job strain, particularly given that workplace stress is an effect of both job-related stress and an interaction between off-the-job and on-the-job stress (Beermann and Nachreiner, 1995). Moreover, research has demonstrated that greater levels of family support are more predictive of active coping strategies and efforts to seek emotional support when under stress (Cronkite and Moos, 1984; Holahan and Moos, 1987), particularly when under high stress levels (Holahan and Moos, 1991).

Yet at present no methodologically sound study has employed an integrative approach to studying workplace stress that incorporates the contributions of domestic social support away from the workplace in determining shiftworkers' physical health, psychological health, or operational safety and performance. Therefore the present integrative predictive model incorporates a measure of social support away from the workplace – spouse/partner support – to provide a measure of support that refines and broadens Karasek's earlier conceptualizations, and in so doing aims to more accurately identify underlying relationships between stress and strain.

Furthermore, even when considering just the work environment, Karasek's demand-control paradigm does not address the power structure at the worksite (Kristensen, 1995). For example, as discussed earlier in the chapter, the opportunity to play a meaningful role in selecting one's own work schedule may add an important element of control that significantly influences one's biopsychosocial adjustment both on and off the job (Terry, 1991; Smith and Barton, 1994; Heaney, 1995; Knauth & Costa, 1996).

Thus the present integrative study, building upon recent theoretical advances in the field (Barton, 1995; Heaney, 1995; Kogi, 1991; Kogi and diMartino, 1995; Smith and Barton, 1994), proposes a process that aims to attenuate existing levels of biopsychosocial stress a through scheduling intervention that maximizes employee participation and control. In the present conceptual model, therefore, the ability to influence selection of the work schedule is conceptualized as a significant stress variable capable of affecting health and behavioral outcomes (Carver et al., 1989; Folkman, 1984; Heaney, 1995; Terry, 1991).

Work Schedule as Stress Variable

Broadly there exists a consensus that shiftwork can contribute to a range of adverse effects on health and well-being (Barton, 1995; Bohle and Tilley, 1993; Costa, 1993; Walker, 1985). Not surprisingly, the dynamics of the schedule itself likely play a significant role in coping with shiftwork stress (Akerstedt, 1997; Folkard, 1990; Monk, 1986). Moreover, as discussed in Chapter 3, there is considerable potential for <u>differences in demand</u> among various shift schedules in operation (Hornberger and Knauth, 1995) and within identical shift schedules (Barton, 1995) given unique site-specific and/or job-specific parameters.

Perhaps most importantly, employee preferences based on predisposition, family circumstances, social commitments, and other biopsychosocial factors likely contribute significantly to schedule adaptation and consequent alertness over time, influencing coping response set effectiveness and adjustment. Thus, the present study conceptualizes schedule demand as the degree to which a schedule impacts an employee's ability to maintain alertness, and in so doing serves as a predictor of downstream coping effectiveness and subsequent adjustment.

Although individual tolerance for schedule pattern variation seems a conceptually relevant approach, particularly given the many permutations and combinations of factors that characterize schedule design and the ongoing debate as to the pros and cons of different families of schedules, that is not to say that consideration of frank schedule parameters is not a worthwhile endeavor. In the present study, however, the primary schedule demand component of the integrative model is operationalized as employee-specific, schedule-related shiftwork tolerance as measured by a schedule's effect on alertness over time, and as such forms an important core dimension underscoring the proposed demand-control-support conceptualization.

Coping as Mediator

As developed in Chapter 1's historical review (Cohen and Lazarus, 1979; Fleishman, 1984; Pearlin and Schooler, 1978) and demonstrated in Chapter 4's present theoretical conceptualization (Carver et al., 1993; Cohen and Edwards, 1989), coping remains a central aspect of contemporary theories of stress. More specifically, Fleishman (1984) defines coping as cognitive or behavioral responses "to reduce or eliminate psychological distress or stressful conditions", while at a broader level coping is viewed as a stabilizing factor that can help individuals maintain psychosocial adaptation during stressful periods (Lazarus and Folkman, 1984; Moos and Schaefer, 1993).

Applying previous research on stress and coping processes in general (Cohen and McKay, 1984; Dalbokova, 1995; Holahan and Moos, 1991; Lazarus and Folkman, 1984; Menaghan, 1982; Pearlin and Schooler, 1978, Thoits, 1986) and shiftwork stress and coping in particular (Akerstedt and Torsvall, 1981; Barton et al., 1995; Beermann and Nachreiner, 1995; Karasek, et al., 1982; Theorell and Karasek, 1996; Verhaegen et al., 1987; Wedderburn, 1995), a general model of coping is proposed where levels of shiftwork stress relate to adjustment both directly and indirectly through mediating coping processes. More specifically, as illustrated in Figure 2 (page 110), predictive paths in the proposed model relating to mediating coping processes are hypothesized to be more robust for those shiftworkers tapping a greater breadth and depth of adaptive coping strategies.

Thus coping strategies are conceptualized as playing a significant role in mediating the effects of stressful stimuli on adjustment (Carver and Scheier, 1994; Folkman and Lazarus, 1985; Vitaliano, DeWolfe, Maiuro, Russo, and Katon, 1990). The present study further proposes that the mediating effects of coping are moderated by levels of support (Cohen and McKay, 1984; Thoits, 1985) and control (Lazarus and Folkman, 1984; Smith et al., 1995; Strickland, 1978).

Accordingly, the present conceptualization of coping as a mediator contributes to theoretical and practical understanding in three important ways. First, it allows for a broadened and more refined conceptualization of coping processes relating to both stress in general and shiftwork stress in particular. Second, it allows for enhanced understanding of moderating support and control processes. Third, it tests a framework through which support and control variables function to predict adjustment.

Support as Moderator

A substantial body of research argues for the role of social support as a buffer against the harmful effects of stress (Cohen and McKay, 1984; Cohen and Wills, 1985; Thoits, 1985). Specifically, Thoits (1986) conceptualized social support as a coping resource. As well, resources including social support were defined by Lazarus and Folkman (1984) as what an individual "draws on in order to cope." Furthermore, they argued that such resources both precede and affect the coping process. Thus social support has been construed in the literature as influential in predicting coping strategies under stress.

On the basis of these findings, the present model hypothesizes that support is associated, through mediating coping processes, with adjustment. More specifically, as demonstrated in Figure 2 (page 110), the predictive paths in the present model are hypothesized to be more robust for those shiftworkers with greater levels of spouse/partner support.

Control as Moderator

Karasek's (1979) demand-control job strain model (see Figure 1, page 74) and subsequent revisions neglect <u>individual differences</u> concerning both susceptibility to strain and ability to cope when under strain (Kristensen, 1995). This presents an important opportunity for refinement, as Holahan and Moos (1991) showed that the robustness of predictive associations in a general model of coping varied according to moderating contextual factors.

Based on these and other findings (Akerstedt and Torsvall, 1981; Barton, 1995; Bohle and Tilley, 1989; Kobasa, 1982; Rotter, 1966; Lazarus and Folkman, 1984; Smith et al., 1995; Strickland, 1978) the present study theorizes that a conceptual model of coping with shiftwork stress would be strengthened by integrating both individual differences and contextual factors in predicting mediating coping strategies and adjustment outcomes within a demand-control-support framework.

One factor suggested to contribute important individual and contextual influences in coping with shiftwork stress is control. Based on the rationale developed in the earlier discussion on shiftwork specific locus of control (Costa et al., 1989; Rotter, 1966; Smith, 1995; Spector, 1988) the present study reasons that individual levels of shiftwork specific locus of control moderate the effects of mediating coping processes on subsequent changes in adjustment. That is, the predictive paths in the present model are hypothesized to be more robust for those shiftworkers with greater levels of shiftwork specific locus of control.

Regarding contextual factors, theorists have suggested that the adaptive significance of approach coping strategies, for example, may depend on the controllability of a stressor (Folkman, 1984; Roth and Cohen, 1986). In the current model, contextual factors concerning the controllability and preference for the current work schedule are therefore also reasoned to moderate the mediating effects of coping on adjustment.

Such a conceptualization, incorporating both individual (Smith et al., 1995) and contextual (Roth and Cohen, 1986) differences in control may better inform the effects of shiftwork stressors on strain and subsequent adjustment. In so doing, the present integrative model provides a broadened and more refined revision of Karasek's (1979) original demand-control conceptualization.

AIMS OF THE PRESENT STUDY

The present study proposes to address several emerging issues in stress and coping research as well as the specific challenges of coping with shiftwork stress in an effort to <u>better understand and optimize</u> <u>stress resistance and related health and performance outcomes</u>. More specifically, integrating academic research and industrial application, the present study aims to introduce a <u>biopsychosocial coping toolbox</u> into an industrial shiftwork setting in an effort to optimize physical and psychological adjustment, safety and operational performance around-the-clock. In so doing, the current study examines three primary areas of interest: a collaborative intervention process, a broadened demand-control-support framework, and a refined coping categorization in a longitudinal shiftwork model of stress resistance.

As well, the present study explores several additional potential moderators of secondary interest, including gender, ethnicity, age, and years of shiftwork. Finally, the current study also addresses several methodological challenges in shiftwork stress research and proposes additional topics of inquiry to explore new directions in stress resistance optimization.

First, the present study proposes to examine the singular and combined effects of a multimodal schedule demand intervention in predicting subsequent adjustment approximately twelve months after baseline survey measurement in an employee-driven schedule selection process (Circadian Technologies, Inc. (CTI), 1993) including shiftworker lifestyle training (Circadian Technologies Inc. (CTI), 1995). More specifically, the scheduling initiative aims to attenuate schedule demand by integrating biopsychosocial theory into schedule design and selection, while the training intervention delivers modules on the biological clock, sleep, alertness, safety, family and social life, nutrition, and wellness in an effort to further support the efficacy of the scheduling intervention.

Second, the present study proposes to examine the mechanisms through which moderating control and support variables influence adjustment to stress through mediating coping processes. In so doing, the present study aims to explore the usefulness of a broadened demand-control-support framework in predicting adjustment to stress across varying levels of exposure. Moreover, in expanding Karasek's

(1979) original demand-control model, the present study aims to integrate current theoretical advances in stress and coping research (see Beermann and Nachreiner, 1995; Folkman and Lazarus, 1985; Smith and Barton, 1994) and methodology (see Kristensen, 1995; Totterdell, 1995; Totterdell and Folkard, 1990).

Third, the current study proposes to enrich our understanding of coping processes beyond simple approach and avoidance (Roth and Cohen, 1986) by including a third coping domain termed auxiliary coping. Interestingly, whereas previous research tends to identify approach coping as uniquely associated with better psychological outcomes (Compas, Malcarne, and Fondacaro, 1988; Vitaliano, Maiuro, and Russo, 1987), a study exploring auxiliary coping processes as a functionally distinct coping strategy suggests that this latter coping style relates positively to optimism (Lehrer, 1996). This is important, since optimism is a personality variable that has been shown to relate to better psychological adjustment (Carver, et al., 1993; Stanton and Snider, 1993). Thus by extending Carver's measures of approach and avoidance coping with the expanded measure of auxiliary coping, the present study proposes to refine the identification and categorization of coping processes relating to adjustment.

In summary, the present study applies important theoretical and methodological advances suggested in the literature, introduces a shiftwork model of imposed stress and proposes to integrate a broadened demand-control-support framework, a longitudinal intervention process, and a refined coping classification to explore stress response processes and subsequent effects on adjustment. In so doing, the present study aims to enrich the understanding of individual differences and environmental processes as strategic components in implementing strategies to buffer the deleterious effects of stressors affecting psychological health, physical health, safety and operational performance. Shiftwork represents an important domain in which to better conceptualize such processes, given both the acute (Costa, et al., 1995) and chronic (Torsvall et al., 1981; Waterhouse et al., 1992) nature of shiftwork as a stressor.

To achieve these goals, the present study's design uses a comprehensive employee survey battery in conjunction with management and employee interviews as well as employer safety, health, and accident records to test the proposed integrative model. The experimental design incorporates longitudinal data from a large sample of representative shiftworkers to test the model within the context of an appropriate and sufficiently sizable population.

Given that shiftwork is increasingly widespread in industry and services (Kogi, 1995), and approximately 20% of full time American employees work nonstandard hours (Reese, 1996), the clinical implications of refining our understanding of coping with shiftwork stress are exciting. Maladaptive response patterns may be moderated through a better understanding of the nature of coping and its malleability in response to moderating effects of control and support. Moreover, such findings may encourage coordinated implementation of proactive interventions aimed at improving stress resistance while facilitating both adaptive lifestyle changes and improvements in operational performance through the introduction and optimization of biopsychosocial work environments.

HYPOTHESES

Figures 2 and 3 (pages 110 and 111, respectively) illustrate the integrative model's proposed theoretical framework for the hypotheses that follow. Adjustment is operationalized in the present model as a dimension that integrates measures of psychological health, physical health, and operational performance in an effort to tap indices of mental and physical well-being, safety and productivity (see Materials, page 154 and Table 7: Variable Labels, Names, and Descriptions, page 185 for scale construction metrics and background).

Hypotheses Relating to the Predictive Roles of Schedule Demand, Schedule Selection Preference, & Shiftworker Training Interventions

Hypotheses 1 through 3 concern the primary intervention components of the integrative predictive model. More specifically, the hypotheses explore the roles of schedule demand, schedule preference, & shiftworker lifestyle training in predicting adjustment.

Hypothesis 1:

Applying previous research, it is predicted that decreased schedule demand (Akerstedt, 1997; Barton, 1995; Folkard, 90; Hornberger and

Knauth, 1995; Monk, 1986, Verhaegen, et al., 1987), preferred shiftwork schedule selection (Barton, 1993; Costa, 1989; Smith and Barton, 1994) and participation in shiftworker lifestyle training (Wedderburn, 2000; Barrett, 1995; Folkard et al., 1978; Kundi et al., 1981; Nicholson and Marks, 1983; Waterhouse, 1992; National Sleep Foundation, 1999) will make significant, independent contributions in predicting positive subsequent adjustment.

Hypothesis 2:

Moreover, it is predicted that schedule demand, selection, and training will operate interactively in predicting subsequent adjustment. That is, it is anticipated that the combination of improved schedule demand, selected schedule preference, and training participation will predict a more robust positive influence on subsequent adjustment than would be achieved independently.

Hypothesis 3:

Consistent with previous findings and suggestions, it is predicted that preferred schedule selection, and shiftworker lifestyle training will independently and interactively positively relate to shiftwork locus-of-control (Barton, 1993; Costa, 1989; Karasek, 1979; Heaney, 1994; Karasek and Theorell, 1990; Smith et al., 1995; Smith and Barton, 1994) and spouse/partner social support (Barrett, 1995; Dunkel-Schetter et al. ,1987; Folkard et al., 1978; Heaney, 1995; Kundi et al., 1981; Nicholson and Marks, 1983; Waterhouse, 1992).

Hypotheses Relating to the Mediating Role of Coping

Hypotheses 4 through 7 concern the mediating role of coping flexibility in the integrative predictive model; specifically, breadth and depth of coping responses are tested as mechanisms through which schedule demand, schedule selection, and lifestyle training interventions longitudinally predict adjustment outcomes.

Hypothesis 4:

Extending previous research, it is predicted that adaptive coping flexibility, including both approach (see Lazarus and Folkman, 1984; Holahan and Moos, 1991) and auxiliary coping responses (see Lehrer, 1996) will be positively associated with subsequent adjustment. Moreover, it is predicted that approach and auxiliary coping will operate interactively in predicting subsequent adjustment. Specifically, it is anticipated that the high approach – high auxiliary combination will show a more robust positive influence on adjustment than either would operating independently.

Hypotheses 5:

Consistent with previous findings and suggestions, it is predicted that lower levels of schedule demand (Barrett, 1995; Folkard et al., 1978; Kundi et al., 1981; Nicholson and Marks, 1983; Waterhouse, 1992), implementation of a preferred shift schedule (Heaney, 1995; Smith and Barton, 1994; Terry, 1991; Wallace and Greenwood, 1995), and participation in shiftworker lifestyle training (Barrett, 1995; Folkard et al., 1978; Kundi et al., 1981; Nicholson and Marks, 1983; Waterhouse, 1992) will be positively associated with subsequent coping responses.

Hypotheses 6:

Moreover, it is predicted that schedule demand, selection, and training will operate interactively in predicting subsequent coping responses. Specifically, it is anticipated that the combination of improved schedule demand, selected schedule preference, and training participation will predict a more robust positive influence on subsequent coping responses than would be achieved independently.

Hypothesis 7:

Integrating previous findings, it is predicted that schedule demand (see Barrett, 1995; Folkard et al., 1978; Kundi et al., 1981; Nicholson and Marks, 1983; Waterhouse, 1992), schedule preference (see Heaney, 1995; Smith and Barton, 1994; Terry, 1991; Wallace and Greenwood, 1995), and shiftworker lifestyle training (see Barrett, 1995; Folkard et al., 1978; Kundi et al., 1981; Nicholson and Marks, 1983; Waterhouse, 1992; Shapiro, 1997) will both independently and interactively relate positively to subsequent adjustment through mediating coping processes, and that these relationships will be stronger than when controlling for the contributions of coping as a proposed mediating mechanism.

Hypotheses Relating to the Predictive Roles of Shiftwork Locus of Control and Spouse/Partner Support

Hypotheses 8 and 9 concern the predictive roles of shiftwork locus of control and spouse/partner support in the integrative path model.

Hypothesis 8:

Extending previous findings, it is predicted that individual shiftwork-specific locus of control (Barton, 1993; Costa, 1989; Smith and Barton, 1994) and spouse/partner social support (Cronkite and Moos, 1984; Heaney, 1995; Holahan and Moos, 1991; Lazarus and Folkman, 1984; Thoits, 1986) will show independent and interactive contributions in predicting subsequent adjustment.

Hypothesis 9:

Integrating previous findings, it is predicted that shiftwork-specific locus of control (Barton, 1993; Costa, 1989; Smith and Barton, 1994) and spouse/partner social support (Cronkite and Moos, 1984; Heaney, 1995; Holahan and Moos, 1991; Lazarus and Folkman, 1984; Thoits, 1986) will both independently and interactively relate positively to subsequent adjustment through mediating coping processes, and that these relationships will be stronger than when controlling for the contributions of coping as a proposed mediating mechanism.

Hypotheses Relating to the Exploratory Moderating Roles of Age, Years of Shiftwork, Gender, and Ethnicity

Hypothesis 10 concerns additional exploratory moderating variables including age, years of shiftwork, gender and ethnicity.

Hypothesis 10:

Extending the findings of previous research, it is predicted that schedule demand will predict poorer subsequent adjustment for employees at or above the age of forty five (see Akerstedt and Torsvall, 1981; Barton, 1995; Spelten et al., 1995; Brugere et al., 1997), and for employees with fifteen or more years of shiftwork experience (see Beermann and Nachreiner, 1990; Nachreiner, et al., 1995; Heslegrave, 1998). Moreover, it is predicted that age and years of shiftwork will operate interactively in moderating predicted relationships. Specifically, it is anticipated that the high age, high years of shiftwork combination will predict poorer adjustment than would be expected if either operated independently.

Gender and ethnicity are also explored as further secondary areas of interest in the present study to investigate how they might relate to adjustment outcomes as well as to mediating and moderating components of the integrative model. No specific a priori hypotheses are postulated; rather, the two variables are explored in an effort to promote further study concerning their roles in stress and coping processes, particularly in the context of optimizing stress resistance and health outcomes across gender and ethnicity.

Chapter 5: Method

SUBJECTS

1727 of approximately 2020 unionized shiftworkers employed at a continuous operation production facility in the Southeastern United States voluntarily participated in the present study. Participants were aware that initial survey items from <u>all</u> respondents would be integrated into a biopsychosocial schedule redesign process subject to subsequent union membership voting by functional work group. Table 2 presents five validity criteria that participants – less attrition (e.g., retirement, disability, dismissal, resignation) – had to satisfy to qualify as valid subjects. 603 participants successfully met these criteria and therefore comprise the present study's sample population. Appendix C documents the subject validity criteria results sequentially during each stage of the process.

Table 2. Subject Validity Criteria

Criteria	Shiftworker had to:
1	Complete and return both Survey I and Survey II (pre- and post-implementation surveys, respectively).
2	Enter an assigned four-digit anonymous identification number correctly on both surveys, thus allowing for pre-post comparisons.[a]
3	Respond in Survey II to a nine-item validity scale (Eysenck & Eysenck, 1963) with a minimum of three valid responses.[b]
4	Endorse primary work responsibilities for one and only one functional work group in Survey I and in Survey II.
5	Provide identical gender and ethnicity data in Survey I and II.

[a]To protect confidentiality, neither management nor coworkers could identify individual responses.
[b]See Appendix C: Rationale to Determine Cutoff Point in Eysenck Validity Scale.

Demographically, the sample population included 36.7% female and 63.3% male subjects. Interestingly, ethnicity data was largely bimodal, with 31.0% African American, 68.2% Caucasian, 0.0% Hispanic, 0.2% Asian, and 0.7% other. Thus African American and Caucasian ethnicities comprised 99.2% of the sample population and therefore represent data of statistical interest in the present study. Table 3 describes the sample population more specifically using crosstabulations of increasing complexity to examine exploratory moderating variables of particular interest, including gender, ethnicity, years of shiftwork, and age.

More than two thirds of the sample population were married, with 11.1% single, 17.4% separated or divorced, 1.8% partnered, 68.8% married, and 0.5% widowed. Mean subject age was 40.26 years at Survey I (ranging from 21 to 59 years, SD = 7.44), and mean level of education was 12.09 years (ranging from 1 to 16 years, SD = 1.87).

All subjects received hourly pay for their participation in the survey portions of the present study. Additionally, for participation in the shiftworker lifestyle training intervention component, all participating subjects were eligible for three separate $100 raffles during their particular training session as well as one automobile raffle across all sessions.

At baseline all participants were working a repeating shift pattern of six consecutive days on followed by two days off, with each individual

Table 3. Gender by Ethnicity, Years Shiftwork by Gender by Ethnicity, Age by Gender by Ethnicity, and Years Shiftwork by Age by Gender by Ethnicity

Years Shiftwork	Age			Ethnicity: African American/ Black	Ethnicity: Caucasian/ White	Total
		Gender	**female**	**103 (17.2%)**	**118 (19.7%)**	**221 (37.0%)**
			male	**84 (14.0%)**	**293 (49.0%)**	**377 (63.0%)**
		Total		**187 (31.3%)**	**411 (68.7%)**	**598 (100%)**
< 15 years		Gender	female	63	68	131
			male	43	142	185
		Total		106	210	316
≥ 15 years		Gender	female	40	50	90
			male	41	150	191
		Total		81	200	281
	18 - 34	**Gender**	**female**	**12**	**23**	**35**
			male	**16**	**61**	**77**
		Total		**28**	**84**	**112**
	35 - 44	**Gender**	**female**	**60**	**55**	**115**
			male	**27**	**146**	**173**
		Total		**87**	**201**	**288**
	45+	**Gender**	**female**	**31**	**38**	**69**
			male	**41**	**86**	**127**
		Total		**72**	**124**	**196**
< 15 years	18 - 34	Gender	female	12	23	35
			male	16	56	72
		Total		28	79	107
	35 - 44	Gender	female	36	27	63
			male	16	65	81
		Total		52	92	144
	45+	Gender	female	15	17	32
			male	11	21	32
		Total		26	38	64
≥ 15 years	**18 - 34**	**Gender**	**female**			
			male		**4**	**4**
		Total			**4**	**4**
	35 - 44	**Gender**	**female**	**24**	**28**	**52**
			male	**11**	**81**	**92**
		Total		**35**	**109**	**144**
	45+	**Gender**	**female**	**16**	**21**	**37**
			male	**30**	**65**	**95**
		Total		**46**	**86**	**132**

Note. Crosstabulations examine sample data for African American/Black and Caucasian/White ethnicities, as these ethnicities represent 99.2% of the sample population.

being regularly scheduled to work a shift during either the day (7 a.m. to 3 p.m.), evening (3 p.m. to 11 p.m.), or night (11 p.m. to 7 a.m.). The shiftworkers did not rotate among the three time slots, but were instead fixed in their regularly scheduled work periods (i.e., 6-2 fixed eights).

Subjects also belonged to one of eight functional workgroups. These work groups varied by job classification, number of employees, and duties. Each are briefly described below, with the corresponding number of qualifying participants (Survey I/Survey II):

Fabrication Technician (FAB), 364/348 of approximately 1000 shiftworkers: These employees run the "makers" and "packers" and thus are directly involved with the product as it is produced and packaged.

Senior Fabrication Technician (SFT), 113/126 of approximately 350 shiftworkers: These employees repair the fabrication equipment and thus help maintain the viability of the operation. They perform largely mechanical duties.

Primary Technician (Primary), 45/49 of approximately 250 shiftworkers: These employees have largely labor intensive responsibilities including performance of manual janitorial-type functions on the factory floor. At times they also drive heisters.

Senior Primary Technician (SPT) 12/17 of approximately 70 shiftworkers: These employees are skilled laborers and work in control rooms monitoring the flow of product throughout the plant, making modifications as required.

<u>Electrical Technician</u> (EET), 31/28 of approximately 100 shiftworkers: These employees are electricians and perform electrical maintenance and repairs.

<u>Parts</u>, 2/2 of approximately 50 shiftworkers: These employees work in the stock room to manage inventory using a computerized data entry system.

<u>Supply</u>, 23/21 of approximately 100 shiftworkers: These employees provide supplies to fabrication, and, like the Primary functional group, do more labor intensive tasks then the other classifications. Also, they operate trucks.

<u>Shipping</u>, 13/12 of approximately 100 shiftworkers: These employees are responsible for staging materials and work largely with heisters, although they also perform some manual stacking. They are responsible for checking counts and minimizing loading errors.

PROCEDURE

The present study is longitudinal, utilizing pre- and post-implementation survey batteries and objective group longitudinal data gathered through the site's medical and environmental health and safety departments, as well as data gathered through on-site interviews with shiftworkers and management. The self-report variables were obtained from two surveys administered approximately twelve months apart at baseline (Survey I) and approximately eight months post-scheduling and training implementation (Survey II). The four months immediately following baseline data collection and preceding implementation were utilized to conduct a Shift Schedule Optimization Project (SSOP; CTI, 1993) described later in this chapter. After schedules were rendered, communicated, and selected for implementation, training on Managing a Shiftwork Lifestyle (MSL; CTI, 1995) was offered contiguous with implementation to optimize efficacy of both scheduling and training initiatives.

Thus both scheduling and training interventions were implemented approximately four months after Survey I administration. This allowed adequate time for development of the quasi-experimental manipulations. Specifically, information gathered from Survey I was utilized in designing biocompatible shift schedules that optimally met each work group's unique set of psychosocial preferences within the context of pre-established management boundary conditions (e.g., round-the-clock plant operations). Moreover, shiftworker lifestyle training was designed to augment biopsychosocial improvements predicted through the scheduling redesign process.

During Survey I, subjects completed anonymous, randomly coded questionnaires assessing a variety of areas relating to alertness, health, safety and performance, including coping strategies, internal levels of control, social support at work, social support away from work, psychological health, physical health, accidents and injuries, and perceived job demands, as well as scheduling preferences and important demographic data such as age, gender, years of shiftwork, and ethnicity (see Appendix A for study measures relating to the integrative model).

During Survey II, subjects again completed all model-related questionnaires as in Survey I, although in Survey II subjects were not asked to provide identical schedule preference information previously used to aid in the development of biopsychosocial scheduling alternatives. Instead, Survey II respondents provided new data concerning their assessment of scheduling and lifestyle training efficacy (see Appendix A) in promoting biopsychosocial adjustment (see Taylor, 1991) and operational performance.

All subjects were encouraged to participate in both the Shift Schedule Optimization Project (Intervention A) and the training on Managing a Shiftwork Lifestyle (Intervention B). The SSOP intervention involved a coordinated series of steps to identify optimal schedules by functional group, while the MSL training was offered as a useful tool for coping with shiftwork stress. Additionally, the same shiftworkers were encouraged to bring their spouse or partner to the MSL training session.

Listed below is the 16-step SSOP/MSL process followed by a brief description of each step:

1) Convene Management Meetings
2) Formulate Task Team
3) Create Communication Video
4) Conduct Interviews
5) Prepare Survey
6) Administer Survey
7) Analyze Survey
8) Present Survey Results and Define Schedule Criteria
9) Design Schedule Options
10) Present Schedule Options
11) Review Schedule Options Prior to Voting
12) Hold Initial Balloting
13) Review Final Two Options and Select Final Option by Ballot
14) Vote On Winning Option Versus Current Schedule
15) Initiate Implementation Strategy
16) Conduct MSL Training Intervention

1) Management meetings were conducted to determine boundary conditions for the Shift Schedule Optimization Project (SSOP; CTI, 1993), as well as to identify roles and responsibilities among management, labor,

union officials, and the third party facilitator. It was mutually determined among all parties that each of the 8 functional workgroups previously described would be permitted to undergo a separate SSOP, thereby tailoring the process to each group's specific preferences.

Moreover, management imposed no restrictions on alternative schedule choices beyond the requirement that all options must mathematically support around-the-clock operations. By foregoing any of a number of confining boundary conditions (e.g., one schedule must be implemented throughout the plant, the schedule must be rotating, it must start at 6 a.m., and it must be based on 8-hour shifts), management left the choice largely up to the employees and the process. This was generally viewed by the parties involved as allowing for greater control by functional group over final schedule selection.

2) A <u>task team</u> was then established consisting of representative members from the four parties listed in Step 1. As a result, labor and management, interacting with the union leadership and the third party facilitator, were able to communicate openly and share ideas relating to coping with the challenges of working shifts. A timeline was established, and a multimodal communication process was crafted to disseminate information to the approximately 2020 shiftworkers in a timely manner. The task team continued to meet at key stages throughout the SSOP, and large-scale

communication initiatives remained critical throughout the duration of the SSOP and MSL interventions.

Key Task Team member roles and responsibilities are outlined below:

a) Represent their constituency.

b) Become knowledgeable of the process and information.

c) Clearly understand the boundaries and criteria.

d) Implement communications programs.

e) Address questions as they arise.

f) Continually monitor process integrity.

g) Aid with administration of the confidential survey.

h) Review survey results and employee preferences.

i) Review schedules and their associated pros and cons.

j) Help to administer and tally schedule option ballots.

k) Provide input on implementation issues and plans.

l) Monitor new schedule results and satisfaction levels.

3) A communication video was created and played continuously over several days in a number of employee lunch and rest areas and throughout several other key locations in the building, including the main employee entrance. The video was also mailed to every potential subjects' household. This video explained in detail the process as well as some of the mechanics of shift scheduling, so that there would be no surprises along the way and

that all parties would be clear as to the steps involved and their anticipated dates of completion. Moreover, the video emphasized the anonymous nature of the survey and encouraged participants to be forthright in their responses without fear of retribution; that is, neither management nor co-workers ever saw any employee's individual responses. Instead, only group data were reported.

4) Interviews were conducted around-the-clock to speak with a large number of shiftworkers both individually and in small group format. All shiftworkers had the option to speak individually with the third party facilitator.

These informal interviews served three important functions. First, they allowed for a reiteration of the process and clarification of roles and responsibilities. Second, they helped establish rapport with the employee population and attenuate the inherent cynicism that can accompany management funded initiatives. Because there typically exists years of animosity between labor and management, it is important to the success of the project that employees view the initiative as independent of other company sponsored business, since some employees tend to perceive a history of clandestine management agendas including downsizing and/or payroll reduction, even in the absence of such an agenda.

The SSOP process, often in contrast to previous initiatives, proposes to provide equal access of information to all parties so that both labor and management can jointly benefit. This stage of the SSOP typically requires significant attention by the third party facilitator to ensure that as many employees as possible remain open to the process and correctly perceive that their survey responses will in fact be incorporated into a democratic process of schedule selection.

The third important function of the informal interviews was to allow the third party facilitator to become more familiar with the site-specific and job-specific operations being performed. This in turn provided critical insight for incorporation into the schedule design process.

5) Survey I was then prepared and customized according to the site and job-specific information gathered thus far, as well as the third party facilitator's knowledge of biocompatible shift scheduling.

6) Survey I administration was conducted (after again reviewing the SSOP process) by the third party facilitator with aid from the task team over a three day period covering all shifts to ensure maximum availability to employees. The initial survey was administered in a large, contained area set away from the factory floor but still located on worksite premises. This was a conceptual precaution given that when individuals complete questionnaires on the actual work floor, the responses can potentially be somewhat dependent upon temporal work circumstances (Sims, 1995).

Furthermore, as workers completed the survey in a group setting, efforts were taken to ensure that all surveys were individually completed in a quiet environment. This was important, given that collaboration among employees can promote subjective bias in responses (Sims, 1995). Confidentiality was protected by assigning each employee a randomized four digit code number.

Due to management budgetary considerations, Survey II was distributed to employees during their respective shifts, completed during non-work hours, and collected over several days round-the-clock in the presence of task team members to ensure confidentiality and appropriate assignment of anonymous identification numbers as implemented during Survey I administration.

7) An <u>analysis of Survey I results</u> was then performed after the surveys were computer scored using an automated scantron system. Given the magnitude and nature of the SSOP, and in recognition of the significant impact such a process can have on the more than 2000 unionized employees, the union leadership requested that a pair of union representatives accompany the third party facilitator to the New England survey scoring center to ensure that procedures were strictly adhered to. The request was granted and appeared to further enhance rapport and morale among the employee population at large. In fact, this step

appeared to largely dismiss a number of employee concerns relating confidentiality.

8) A presentation of Survey I results was conducted, and individual schedule criteria were defined by functional workgroup in coordination with the task team.

9) Alternative schedules were then designed to incorporate biocompatible scheduling techniques as well as psychosocial enhancements.

10) The presentation of schedule options was then conducted by functional group with the aid of the task team. Pros and cons of the various schedules were discussed, and input was solicited from the shiftworkers to facilitate education and participation.

11) A review of the alternative schedule options was then conducted by functional group prior to voting, and efforts were made to address any concerns and issues relating to the schedule selection process.

12) Initial balloting was then overseen over several days by the third party facilitator assisted by task team members.

13) The final two options were further reviewed as to their pros and cons, and these options were then voted on by functional group.

14) A final ballot was conducted in which the winning option and the current schedule were the two final choices by functional group. Thus either the new option or the old schedule was selected.

15) Implementation plans were initiated to accommodate selected schedule options, including modifications by the payroll department as well as agreement on and communication of several supporting modifications to policies, practices, and procedures relating to work hours, overtime, vacation, relief coverage, maintenance, breaks, sick time, holiday pay, and shift changeover, for example.

16) Training on Managing A Shiftwork Lifestyle (MSL; CTI, 1995) was conducted in groups not exceeding 50 attendees per session (including spouse and/or partner). As part of the training, each corresponding schedule was addressed by functional group in terms of general and specific strategies to better cope with the pending work pattern. Training sessions lasted approximately two and a half hours, condensed from a standard four hour format. Each session consisted of six theatre style interactive modules, listed below and briefly described:

Introduction to Circadian Physiology: This section served as an introduction to the biological clock in the brain and explained its importance to shiftworkers, including why individuals tend to perform better during the day as compared to the night. As well, relevant body functions affected by the clock were discussed.

Shiftworker Sleep Management: This segment discussed sleeping and napping strategies, the physiology of sleep, how to manage and achieve quality sleep, and common sleep disorders.

Shiftwork, Alertness, and Performance: This portion introduced several successful strategies to manage alertness levels, and ways to optimize performance both at home and at work.

Shiftworker Health and Safety: This piece discussed how to anticipate and counter fatigue, including a consideration of specific tasks at work and home where extra precaution is warranted. Safe commuting was highlighted, as was exercise and healthy living.

Shiftwork and Nutrition: This section emphasized wellness planning, integrating healthy eating and time-based nutrition, such as particular foods to avoid on the night shift.

Shiftwork Family and Social Issues: This segment focused on the challenges experienced by shiftworkers and their families, and discussed practical solutions for managing stress, improving communication, implementing coping strategies, dealing with irritability, planning activities, and establishing support systems.

In addition to the six training modules highlighted above, each attendee also received a training manual (one per couple) that followed the presentation and contained supplemental training tools including a circadian profile survey, isometric exercises, sleep logs, a personal change planner, family activities, a caffeine survey, nutrition-related questions and answers, sample menus, and additional planning strategies.

MATERIALS

Surveys I and II each contained 240 multiple choice items and took approximately one hour to complete. Survey I also included two numeric responses to tap continuous data regarding age and education. Appendix A (Survey Scales) identifies and organizes relevant scales while Appendix B (Comprehensive Post-Implementation Survey) presents all demographic, scale and additional survey items sequentially, thus preserving the nature of their administration (Note, Survey II items 19 through 64 (Appendix B) replaced corresponding Survey I schedule preference indicators used to formulate biopsychosocial schedule alternatives).

Broadly, survey items and scales fall across four main categories: outcomes, modifiers, mediators and organizational systems. Outcomes relate to the actual problems experienced by the individuals, modifiers relate to differences among individuals that may serve to interact with intervening mediating effects of coping with shiftwork stress, and organizational systems relate primarily to the demands and structure of the shift pattern and the work environment.

Adjustment

Psychological Adjustment

Psychological adjustment was measured at Session I and Session II through a 12-item version of the General Health Questionnaire (GHQ12) scale (Goldberg and Williams, 1988), as used in the Standard Shiftwork Index (Barton et al., 1995). The GHQ12 (Appendix A) is a unidimensional context-free measure of well-being. More specifically, it is designed to provide a single measure of mental health over the past few weeks.

The measure includes levels of self-confidence (e.g., "Have you recently been thinking of yourself as a worthless person?"), depression ("Have you recently been feeling unhappy and depressed?"), sleep loss ("Have you recently lost much sleep over worry?"), and problem solving ("Have you recently felt capable of making decisions about things?"). The GHQ is also available in 60-, 30-, and 20-item versions. Given the large number of items used in the present study and the satisfactory psychometric properties of the 12-item GHQ, this condensed version was selected for the present study, and is the same format as is also used in the Standard Shiftwork Index (Barton et al., 1995).

The GHQ12 can be scored using two methods, either using a Likert scale (e.g., better than usual, same as usual, less than usual, much less than usual) or a bimodal response scale. The Likert-type scoring method codes items from 0-3, is more suited for multivariate analyses (Banks et al., 1980) and was consequently used for that portion of the analyses in the current study, where items were rated along the 4-point scale and summed. All four GHQ12 subscales required respondents to rate each item over the past few weeks. Higher scores represent poorer well-being.

The 12-item version of the GHQ has previously demonstrated moderately high internal consistency (α = .89 and .88 for nursing and industrial populations, respectively; Barton et al., 1995). This is meaningful, since Nunnally (1978) has suggested that alpha is the most important index of internal reliability. In the present study, internal consistency for the full scale GHQ measure of overall mental well-being was high during both Session I (α = .92) and Session II (α = .93). As well, the GHQ subscales demonstrated moderate to moderately high internal reliability (Session I α = .83, .81, and .76, and Session II α = .87, .83, and .81 for depression, self confidence, and problem solving, respectively). The sleep loss subscale consists of only one item and contributed to the GHQ full scale reliability analyses described above.

Furthermore, evidence suggests that the GHQ demonstrates good concurrent validity and correlates well with other psychiatric screening tests (Goldberg et al., 1976) including the Symptom Checklist-90 developed by Derogatis et al. (1973). As well, the GHQ12 has been shown to reflect the psychological effects of external events that may be expected to increase or decrease stress (Barton et al., 1995). Moreover, a study using the 12-item version of the GHQ suggested that night work had a significant effect on psychological well-being (Bohle and Tilley, 1989). High correlations between all employed measures of well-being suggest that these measurements can be combined into one measure of overall well-being (Daniels and Guppy, 1995).

Physical Adjustment

Physical adjustment was measured at Session 1 and Session 2 through the 19-item Physical Health Questionnaire, as used in the Standard Shiftwork Index (Barton et al., 1995). This instrument was developed because of the need for a standardized questionnaire that focuses specifically on measurements of cardiovascular and digestive concerns. Items were selected from existing health measures, including the Inventory of Subjective Health (Dirken, 1967) and the Health Survey (Spence et al., 1987), as well as from discussions with health specialists in cardiology, gastroenterology, and occupational health (Barton et al., 1995).

The core questionnaire (Appendix A) contains two subscales relating to symptoms, an 11-item cardiovascular subscale ("How often do you suffer from aches and pains in your chest?") and an 8-item digestive subscale (e.g., "How often do you suffer from heartburn or stomach ache?"). Items for the cardiovascular and digestive subscales were coded along a 4-point Likert scale (almost never, quite seldom, quite often, almost always), with a sum score computed for each subscale, and a total sum score computed for the overall PHQ scale. Higher scores are associated with a greater frequency of symptom occurrence.

Interestingly, factor analysis of the cardiovascular and digestive symptomatology had previously identified two distinct factors, with symptoms loading on the appropriate subscales (Barton et al., 1995). In prior studies, the 19-item Physical Health Questionnaire demonstrated adequate internal reliability for cardiovascular symptoms (α = .76 and .71 for industrial and nursing populations, respectively; Barton et al., 1995) and good internal consistency for digestive symptoms (α = .86 and .84 for industrial and nursing populations, respectively; Barton et al., 1995). Internal consistency for the Physical Health Questionnaire in the present study was moderately high to high (Session I α = .83, .90, and .90, and Session II α = .85, .92, and .92 for cardiovascular, digestive, and combined scales, respectively, with the core 19-item scale selected for initial analyses in the present study). Although additional texture might be gleaned by also separately considering the relationships between cardiovascular or digestive symptomatology and other study variables, the PHQ scale is utilized as a sum scale indice of both cardiovascular and digestive health in the present study.

Additionally, consistent with Kristensen's (1995) suggestions for multiple traits and methods, a 23-item checklist (Appendix A) of diagnosed medical conditions (e.g., high blood pressure, high cholesterol, gastric or duodenal ulcer, colitis) suffered both before and since working shifts was included (Medical Diagnosis section of Standard Shiftwork Index; Barton, et al., 1995). Items were rated along a 3-point scale (before starting shiftwork, since starting shiftwork, never), collapsed into two response groups (0 = never or before starting shiftwork; 1 = since starting shiftwork) and summed, with higher scores representing relatively poorer health since starting shiftwork.

The current study's physical health index was calculated by summing the z-score transformations for both the PHQ and Med survey data. Thus, the physical health (Phys) measure contained data on cardiovascular health, digestive health, and actual reported medical diagnoses since beginning shiftwork.

Operational Performance

Safety

Safety measures were defined on both empirical and conceptual grounds, including both OSHA-related safety incidence and severity rates tracked by functional work group, as well as a 4-item employee survey measure. Empirically, safety was measured to explore the severity and frequency of incidents and to identify predictable patterns in which greater risk may exist for the occurrence of future incidents adversely impacting safety and related operational performance. Archival data was gathered through the operation's Environmental Health and Safety and Medical departments to provide an objective longitudinal assessment of occurrences by work schedule and by microfunctional work group. These generally smaller workgroups were then composited into the eight functional work areas selected in the present study for schedule optimization and shiftworker lifestyle training.

Principal Components Analyses were then performed post follow-up (see Results, page 184) to optimally group safety indices. Archived measures included the following records:

- OSHA recordable cases.
- Lost workday cases.
- Lost workdays.
- All reported accidents.

More specifically, the present study analyzed records from OSHA's Log and Summary of Occupational Injuries and Illnesses (OSHA 200 Log Form, 1999, see Appendix C), which requires objective reporting of injuries and illnesses according to the following criteria:

> "You are required to record information about every occupational death; every nonfatal occupational illness; and those nonfatal occupational injuries which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid)."

As well, in keeping with Kristensen's (1995) multitrait-multimethod approach (see Campbell & Fiske, 1959, for a thorough review), Lost workday cases were reviewed to identify the number of cases resulting in missed days of regularly scheduled work, while lost workdays measured the number of days away from the job. Additionally, all reported accidents indicated the total number of incidents reported, including those occurrences not qualifying as OSHA recordable. Thus, by studying the number of occurrences across multiple indices, the present study aims to explore safety and related performance as a function of on-the-job accidents and injuries, as well as their impact on both employees and employer.

Longitudinal safety records were obtained for all four indices (OSHA, Cases, Days, Accidents) for 12 months pre-implementation of scheduling and training interventions and 24 months post-implementation following an initial adjustment period to allow adequate time for employees to transition to follow-up schedules and to ensure that all participating functional work groups had completed the requisite operational logistics involved in the rescheduling process.

The unit of measure used to quantify OSHA recordable cases, lost workday cases, and all reported accidents was incident rate, while lost workdays were assessed via severity rate. Specifically, incident rate was defined as the number of accidents (all reported, OSHA recordable, or lost workday cases) related to a common exposure base of 100 full-time workers. This allows accurate comparisons to be made among departments regardless of size, and among companies employing the same industry standard. Table 4 presents Incident Rate (IR) terms and method of calculation (higher incident rates are associated with poorer relative levels of safety).

Table 4. Incident Rate Calculation

Term	Description	Calculation
N	Number of Incidents.	OSHA data for time period.
Base	Base for 100 full time equivalent workers.	200,000 = (40 hours a week x fifty weeks a year).
EH	Total hours worked by all employees in group for time period.	OSHA data for time period.
IR	Incident Rate.	IR = (N x 200,000)/EH

Severity rate was calculated as an added measure of the seriousness of lost workday cases, given that more severe injuries would at first blush tend to result in more days away from work. Table 5 presents Severity Rate (SR) terms and method of calculation (higher severity rates are associated with poorer relative levels of safety).

Table 5. Severity Rate Calculation

Term	Description	Calculation
N	Total days lost .	OSHA data for time period.
Base	Base for 100 full time equivalent workers.	1,000,000
EH	Total hours worked by all employees in group for time period.	OSHA data for time period.
SR	Severity Rate.	SR = (N x 1,000,000)/EH

Additionally, a 4-item measure of safety (see Appendix A) was measured at Session I and Session II. Items included measures relating to both increased safety incident risk (briefly nodding off or falling asleep while at work; briefly nodding off or falling asleep while driving to or from work) and safety near incidents (near accidents, errors, or injuries on the job; near automobile accidents), both conceptualized in the current study as related to performance.

These items were rated on a 5-point Likert-type scale (e.g., for nodding off: several times per day, several times per week, several times per month, several times per year, seldom if ever; for near incidents: 0, 1, 2, 3, 4 or more in the past four months), scored in the same direction and summed, with higher scores indicating poorer safety. In the present study, internal reliability for this safety scale was marginally acceptable during both Session I (α = .64) and Session II (α = .62). Note, the safety measure was designed as an indice of risk, as the incidence of automobile accidents remains relatively low (anecdotally, many shiftworkers often describe themselves as "lucky" and can typically recall incidents when they were able to avoid a driving-related accident despite being dangerously fatigued).

Productivity

A 4-item measure of productivity (see Appendix A) was measured at Session I and Session II. Items included measures relating to both errors ("How often do you make mistakes or mental errors while working on your current schedule?") and sleep ("How many hours of sleep per 24-hour period are you actually getting, on average, during days that you work?"), both conceptualized in the current study as indices of productivity on empirical grounds. For example, research by Thomas and his colleagues (DOT, FRA, 1998) suggests that locomotive engineers experiencing greater levels of sleep debt (i.e., simulated "fast" runs with backwards rotating schedules that result in attenuated sleep duration), use progressively more fuel in a ten-hour run as compared to baseline runs preceded by greater levels of sleep duration prior to simulator operation.

These items were rated on a 5-point Likert-type scale (e.g., for <u>sleep</u>: less than 5 hours, 5 hours, 6 hours, 7 hours, 8 or more hours) for <u>errors</u>: several times per day, several times per week, several times per month, several times per year, seldom if ever), scored in the same direction and summed, with higher scores indicating poorer productivity. In the present study, internal reliability for this productivity scale was marginally acceptable during Session I (α = .68) and acceptable during Session II (α = .70).

Additionally, a 1-item measure of comparative productivity (see Appendix A) was tapped during Session II to comparatively assess employee perception of productivity (Proc) at follow-up versus baseline ("Productivity on the job (now)?"). This item was rated on a 5-point Likert-type scale (e.g., much more, more, the same, less, much less) and summed, with higher scores indicating poorer comparative productivity at follow-up.

Control

Control was integrated into the present model to explore and expand upon the nature of demand and control variables as described in Karasek's (1979) original conceptualization, as well as to examine the role of control as an important component of the present study's longitudinal, integrative framework. Control is conceptualized in the current investigation as individual differences in generalized beliefs about shiftwork locus of control (SHLOC, see Smith, Norman, and Spelten, 1993), which the present study now looks at.

Generalized Shiftwork Locus of Control (SHLOC)

Generalized control beliefs in the context of a shiftworking environment were measured at Sessions I and II using an 8-item modified and condensed version of the 16-item Shiftwork-Specific Locus of Control (SHLOC) scale (Smith, Norman, and Spelten, 1993). The SHLOC was developed to reflect current thinking in LOC theory, which argues that a construct is more effectively framed within a domain-specific conceptualization (e.g., Petersen, 1986 - Job Satisfaction Locus of Control Scale; Jones and Wuebker, 1985 - Safety Locus of Control Scale; Wallston and Wallston, 1976 - Multidimensional Health Locus of Control Scale).

The condensed SCHLOC (Appendix A) was derived from a 9-point Likert-type scale (strongly disagree = 1, strongly agree = 9; Smith, et al., 1996) which measures internally oriented beliefs concerning four shiftwork-related domains: <u>sleep</u> (e.g., "I am responsible for how well I sleep when working shifts"), <u>social life</u> (e.g., "My own behavior influences the extent to which my social life is interfered with when on shifts"), <u>health</u> (e.g., "I control whether or not my health is harmed when I work shifts"), and <u>work performance</u> (e.g., "When on shifts I determine whether or not I get good results at work"). Each domain is comprised of four items.

The SHLOC's scale factor structure has been shown to support the a priori assignment of items to subscales. Moreover, the scale has been previously found to be psychometrically robust with generally supported reliability and validity (Smith, 1996). More specifically, in this previous study the SHLOC demonstrated high internal consistency overall (α = .90) and adequate to moderately high reliability for each of the four subscales (α = .89, .85, .87, and .75 for sleep, social life, work performance, and health, respectively; Smith, 1996).

High shiftwork-related internality was found to be associated with greater alertness on shift, better sleep, fewer physical health complaints, better mental well-being, and fewer problems with family and social life

(Smith, 1996). Convergent validity was supported by the scale's association with other Locus of Control Scales, including the Work Locus of Control Scale (Spector, 1988) and the internal items from the Health Locus of Control scale (Wallston and Wallston, 1978).

To form the condensed SHLOC in the current study, two psychometrically robust items were selected from each subscale. In the current study, each item was rated along a 5-point Likert-type scale (strongly agree, agree, no preference, disagree, and strongly disagree), and total scores were obtained by summing the scores for all items. Low scores indicate a high shiftwork-specific internal orientation, and as noted by Smith (1996) low internality (higher scores) does not necessarily indicate externality.

In the present study, internal consistency for the condensed SHLOC scale was moderately high to high (α = .86 and .90, Session I and II respectively). Session I SHLOC subscales had somewhat mixed reliabilities ranging from poor to adequate (α = .78, .62, .59, and .57 for sleep, social life, work performance, and health, respectively), although Session II SHLOC subscales generally demonstrated adequate reliability (α = .80, .77, .72, and .69 for sleep, social life, work performance, and health, respectively). The robust nature of the composite eight-item SHLOC measure appears to more reliably tap the construct of control and was therefore utilized in the present study.

Social Resources

A measure of social resources was also integrated into the present model to explore an expanded demand-control framework as described in Karasek's (1979) original conceptualization of stress and strain, as well as to examine a specific element of social resources as an important component of the present study's integrative framework. Accordingly, social resources were operationalized in the present study as a measure of spouse/partner social support.

Spouse/Partner Social Support

Spouse/partner social support was measured using a single survey item at Time 1 and Time 2 to gauge whether or not a shiftworker experienced "…enough understanding and emotional support from spouse or partner." The item was scored along a 4-point Likert-type scale (major problem, moderate problem, slight problem, no problem, does not apply). The latter response was scored as "system missing" as not all respondents were married/partnered. Higher scores indicated less perceived support (see Appendix A).

Coping

Coping styles were assessed at Session I and Session II using Carver's (1994) 30-item Brief COPE (Appendix A) to condense the original 60-item COPE (Carver et al., 1989) - an inventory of coping responses with a range of 15 conceptually distinct scales. Table 6 presents Brief COPE subscales, sample items, and current reliability coefficients organized according to the three-level taxonomy of Approach Coping, Auxiliary Coping, and Avoidance Coping underscoring the present study's conceptual framework (see Broadened Coping Taxonomy, Page 93, Chapter 4 as a preface for the following section titled "Coping Domains Defined").

The COPE was partially derived by theoretical formulation; that is, several scales chosen for inclusion measure coping styles of particular theoretical interest. Each scale is brief (four items) and focuses on one particular aspect of coping. Coping responses assessed by the measure range from features of problem focused coping (e.g., planning, active coping), to positive reframing of the situation, to using social support or turning to religion, as well as features of avoidance coping (e.g., behavioral disengagement, denial). The COPE in standard form has previously demonstrated good factorial properties and internal consistency (α= .65 to .90; Carver, et al., 1993).

The 30-item BRIEF COPE was developed in response to subjects becoming inpatient while responding to the full instrument (Carver, 1994). In choosing items to retain for the condensed version, development was guided by strong loadings from previous factor and reliability analyses. This condensed version uses 2 items per subscale, the phrasing of each item reflects what the individual has typically been doing as opposed to what the individual did in one particular situation (e.g., "I've been taking action to try to make the situation better" or "I've been accepting the reality

Table 6. Brief COPE Subscales, Sample Items, and Reliability Alpha Coefficients

Subscale	Sample Item	Pre	Post
Approach Coping			
Active Coping	I've been taking action to try to make the situation better	.66	.76
Planning	I've been trying to come up with a strategy about what to do.	.78	.81
Suppression of Competing Activities	I've been putting aside other activities in order to concentrate on this	.54	.57
Seeking Instrumental Support	I've been talking to someone to find out more about the situation.	.62	.71
Auxiliary Coping			
Acceptance	I've been learning to live with it.	.74	.74
Humor	I've been making fun of the situation.	.80	.79
Positive Reinterpretation and Growth	I've been trying to see it in a different light, to make it seem more positive.	.84	.89
Religion	I've been trying to find comfort in my religion or spiritual beliefs.	.75	.73
Seeking Emotional Social Support	I've been getting emotional support from others.	.72	.74
Avoidance Coping			
Alcohol/Drug Use	I've been using alcohol or other drugs to make myself feel better.	.88	.93
Behavioral Disengagement	I've been giving up the attempt to cope.	.66	.72
Denial	I've been saying to myself "this isn't real."	.67	.72
Mental Disengagement	I've been doing something to think about it less, such as going to movies, watching TV, reading, daydreaming, sleeping, or shopping.	.55	.51
Venting of Emotions	I've been expressing my negative feelings.	.71	.71

Note. Alpha coefficients represent present study reliabilities.

of the fact that it happened"). Each item was rated using a 4-point Likert-type scale (I haven't been doing this at all, I've been doing this a little bit, I've been doing this a medium amount, I've been doing this a lot). Each scale was computed individually as an unweighted sum of responses to the two items that make up that scale (see Appendix A for Brief COPE subscales and sample items).

Internal consistency of the Brief Cope subscales in the present study was generally adequate (average α = .71 and .74 for Surveys I and II respectively). Table 6 presents the pre- and post-implementation internal reliabilities for the subscales used in the present study and also provides corresponding sample items (see Appendix A for all scale items), as well as subscale groupings as explained in the next section.

Coping Domains Defined

To explore the present study's proposal to broaden and refine traditional coping domains, a theoretically derived parsing of coping strategies was adopted based on the assumption of three broad categories of coping: the classical categories of approach and avoidance, as well as a third category termed "auxiliary", conceptualized as neither necessarily approach nor avoidant in nature. Thus, working within the context of Carver's COPE Scales (Carver, Scheier, and Weintraub, 1989), a three-level classification system was conceived to include auxiliary coping (Lehrer, 1996) and applied in the present study (see Table 6, page 170 for sample items, as well as Results, page 184, for further scale metrics):

1. Approach Coping (four subscales): active coping, seeking instrumental social support, planning, suppression of competing activities.
2. Auxiliary Coping (five subscales): acceptance, humor, positive reinterpretation and growth, religion, seeking emotional social support.
3. Avoidance Coping (five subscales): alcohol/drug use, behavioral disengagement, denial, mental disengagement, venting of emotions.

Schedule Demand

Work schedule demand was tapped at Session II through a 3-item Schedule Demand Scale (see Appendix A) measuring schedule-related employee adaptation at follow-up as compared to baseline prior to implementation of the schedule optimization process. The measure included indices of alertness across contexts (e.g., "Alertness on the job?”; “Alertness driving to/from work?”; “Alertness during time off?”). Items were rated using a 5-point Likert-type scale (e.g., much more, more, the same, less, much less) and summed, with higher scores representing greater relative levels of schedule demand imposed by the employee’s work schedule at follow-up as compared to baseline schedule demand. The 3-item Schedule Demand Scale demonstrated moderately high internal consistency in the present study (α = .89 at Session II).

Schedule demand is thus conceptualized in the present study as a function of work schedule demand and therefore affected by characteristics of the particular shift pattern being worked; that is, certain rosters are broadly seen as more stressful than others (Akerstedt, 1997; Barton, 1995; Folkard, 1990. Moreover, consistent with other research (Dahlgren, 1981; Gadbois et al., 1987; Monk & Embrey, 1981; Kieswetter, 1988; Monk & Folkard, 1985; Dalbokova, et al., 1995), perceived task stress and related performance are likely to be affected by imposed stressors relating to subject alertness during task execution.

Understandably, all shift patterns present both unique and shared stress management challenges, and each of the three selected schedules resulting in seven shifts (see Appendix C) implemented as part of the present study's scheduling intervention could potentially be assigned a relative stressor level based on generic considerations of stereotypical biopsychosocial needs described previously in the current text. But this approach falls short of the intervention's goals.

More specifically, the current text (see Chapter 3) specifies the importance of individual preferences, predispositions and circumstances in realizing optimal work schedule efficacy. Applying this framework, it follows that a schedule successfully mitigates demand to the extent that it significantly promote an employee's functional capacity to sustain physiological alertness as determined in part by the "fit" of a particular schedule with the employee's biopsychosoical environment. Thus a consideration of schedule fit and alertness is now examined as a measure of schedule demand, a central component of the longitudinal, integrative model.

In an effort to achieve a more informed approach to testing the potential “goodness of fit” between an employee and an implemented work schedule – the demand level of the work schedule – the present model integrates theoretically and empirically important individual differences that may serve to predict subsequent coping and adjustment outcomes. Such work schedule demand data can better inform stress and coping research efforts as compared to merely generating isolated hypotheses predicting imposed schedule stressor levels without adequately considering the biopsychosocial environment of the employee.

To further illustrate the link between employee preferences and perceptions and the degree to which a schedule affects efficacy from both operational and biopsychosocial perspectives, consider that some employees naturally gravitate toward and prefer working nights, even though the majority of employees seem to prefer – and are biologically better predisposed toward – working days under otherwise similarly controlled environments.

As well, an employee with a relatively short commute may prefer and be more productive working more frequent 8-hour shifts in exchange for more time spent at home during important family activities such as dinner, whereas another employee may instead prefer to work 12-hour shifts even with a longer commute to decrease overall commuting time, reduce fuel expenses, and allow for more enjoyable, recuperative time away from work. Alternatively, an employee with a long commute may instead prefer 8-hour shifts over 12-hour work periods due to a significantly long work/travel day on a 12-hour schedule.

Characteristics of the job itself can also affect one's preference for shift duration as well as the number of consecutive days worked. For example, those required to lift relatively heavy objects may be less inclined to do so on a 12-hour shift, particularly if they are also required to stand throughout much of their work period. In summary, additional variables can affect one's overall preference for and adaptation to an "optimal" schedule beyond frank characteristics of the schedule itself.

The rationale presented in the preceding paragraphs therefore provides the logical underpinnings for the present study's biopsychosocial (Engel, 1977, 1980) approach; that is, to refrain from imposing a pre-conceived "stress rating" based solely on employee schedules absent worker preferences, predispositions and circumstances. Interestingly, there remain several different, albeit logically informed rankings for the schedules produced in the present study, further suggesting that a rigid ranking system not be used. The present study instead explores the effects of an implemented schedule in relationship to an employee's ability to sustain alertness over time.

Schedule Selection Preference

Preference for the selected schedule was objectively assessed using a 1-item measure at Session II (see Table 11, page 209) for those employees that participated in both initial and final schedule selection balloting processes to identify those employees able to work their most preferred schedule among several initial alternative options. Accordingly, employees whose preferred schedule was chosen during both evaluations were coded as 0, while employees whose preferred schedule was not chosen during both evaluations were coded as 1 on the schedule preference measure.

Interestingly, over 98% of the shiftworkers voted on schedule options. It is not unusual to have relatively high employee turnout given the significant influence the resulting schedule(s) can have on one's work/rest pattern, affecting personal, family and social life to varying degrees. It seems likely that at least three factors contributed to the successful participation rate.

First, there was considerable debate both within and among the various functional work groups concerning schedule option merits and challenges. Voting results were quite close in some instances (see Table 11, page 209); employees likely anticipated this to some degree and consequently recognized the importance of their vote. Second, considerable effort was made by the third party facilitator to provide objective information with respect to scheduling options and to encourage active participation in both informal and structured discussions concerning potential choices. Third, the facilitator, in cooperation with the company and the union leadership, utilized several channels of communication to encourage employees to vote, including individual and group meetings, videotaped announcements, flyers, and newsletters.

Given greater than 98% voter participation, participation itself was not integrated into the measure of schedule selection preference; that is, since almost all subjects voted, relatively little statistically relevant information was gathered from knowledge of one's participation. The outcome of the vote, however, was meaningfully different among employee voters and was therefore retained as a variable of interest.

Work schedule selection preference was therefore assessed via survey by establishing whether voting employees voted for the selected schedule in the first and final round, the final but not first round, the first but not final round, or in neither round. Data was then composited and subjects parsed into two groups based on whether or not subjects voted for both first and final round for the selected schedule, indicating they received their first preference among potential schedule options at the time of the voting.

Shiftworker Lifestyle Training

Employee participation in the shiftworker lifestyle training intervention (Managing a Shiftwork Lifestyle, CTI, 1995) was determined at Session II (see Appendix B, item 18) using a 1-item survey measure to assess whether or not employees attended the training session. Employees indicating that they attended training were coded as 1 while those not attending were coded as 2 on the training participation measure.

It is important to note that during each training session all employees and attending spouses/partners were eligible for one of three $100 raffles during their particular training session as well as one automobile raffle across all sessions. Anecdotally, such additional training incentives are atypical; however, the employer determined that such incentives were appropriate given the importance of such training, and made the necessary resources available to provide them.

Exploratory Moderating Variables: Gender, Ethnicity, Age, Years of Shiftwork

To better understand primary variables of interest in the integrative, longitudinal model (see Figure 2, page 110) and to better identify, refine, and implement future strategies aimed at attenuating biopsychosocial stress, the present study explored important demographic data. More specifically, gender, ethnicity, age, and years of shiftwork were each parsed into two groups (gender: female/male; ethnicity: African American/Caucasian; age: $< 45/\geq 45$; and years of shiftwork: $< 15/ \geq 15$) each coded as 0 or 1, respectively, and examined for potential moderating effects on variables central to the present study's conceptual model. Table 3 (page 140) illustrates the levels of these exploratory variables examined in the present study, based both on theoretical considerations discussed in the literature review and practical considerations relating to variable level frequency distributions in the present sample.

ANALYTIC STRATEGY

To test hypotheses relating to the, predictive model (see Figures 2 and 3, pages 110 and 111, respectively), the present study applied several general statistical techniques in an integrative, longitudinal analysis. These techniques included descriptive statistics and zero-order correlations, Analyses of Variance (ANOVA) and Covariance (ANCOVA), Multiple Regression (MR), Principal Components Analysis (PCA), and Structural Equation Modeling (SEM) using LISREL analyses (Joreskog & Sorbom, 1993). As well, power analyses were conducted to determine the probability of finding effects of interest.

The integrative analyses tested the predictive model for all subjects to explore how demand, control and support related at follow-up to outcomes, controlling for adjustment at baseline. Moreover, analyses comparatively tested intervention effects using binary parsing of subjects by training attendance and by schedule preference. The integrative analyses also incorporated multiple regression techniques to study both interaction and independent contribution effects among predictors in the present study.

As well, statistical analyses included structural equation modeling using latent models. More specifically, LISREL models (Joreskog &

Sorbom, 1993) using AMOS software specifying LISREL output were utilized in the present study to combine linear structural relationships and factor structures into a comprehensive model which was then tested in both direct and mediational models.

Zero-Order Correlations

To examine whether patterns of intercorrelations among study variables corresponded with predicted hypotheses, zero-order correlations were derived for all primary variable combinations in the present study. In addition, zero-order correlations between hypothesized predictors such as spouse/partner social support and shiftwork locus of control beliefs were performed to explore expected associations among variables at follow-up.

Analyses of Variance and Covariance

Following initial descriptive statistics and correlations, Analyses of Covariance (ANCOVA) were conducted to examine hypothesized relationships among schedule demand, schedule preference, and training interventions, control and support predictor variables, mediating coping responses, and subsequent adjustment. General levels of adaptive coping as well as levels of approach and auxiliary coping were examined, as were individual indices of adjustment including physical health, psychological health, safety and productivity.

Next, the model was estimated for levels of the intervention measures (schedule demand, schedule preference and lifestyle training) to better understand how predictors relate to outcomes. For each comparison, the analyses explored if the model worked differently for different variable levels. Analyses of Covariance (ANCOVAs) were also conducted longitudinally to examine change in adjustment scores over time. For example, ANCOVA explored whether or not schedule demand improved Time 2 adjustment, controlling for Time 1 adjustment at baseline.

To examine exploratory moderating variables potentially relating to adjustment and the interaction of such variables with schedule demand, two-factor (e.g., age X demand, years of shiftwork X demand, gender X demand, ethnicity X demand) ANCOVAs were performed with exploratory moderating variables parsed into two groups defined by either criteria cutoff (e.g., ≤ 45/> 45 years old) or group association (e.g., female/male), controlling for adjustment at baseline.

Multiple Regression

Multiple regression was conducted to examine the robustness of the demand-control conceptualization as well as the expanded and refined exploratory demand-control-support framework by testing the contributions among these contrasting sets of predictors presented as hypotheses in Chapter 4. Specifically, in predicting adjustment two analyses are conducted using multiple regression. First, model one examines the contributions of schedule demand and shiftwork locus of control on adjustment. Then, model two examines the contributions of schedule demand, shiftwork locus of control, and spouse/partner support on adjustment.

LISREL Analyses

LISREL (see Joreskog and Sorbom, 1993) uses latent variables to test both the expected paths and the goodness of fit of the predicted integrative model, including an examination of mediators, moderators, and outcomes. In so doing, the longitudinal model tests the relationship between a set of biopsychosocial and work-related variables at follow-up, controlling for adjustment at baseline.

Analysis of Mediational Model

The hypothesized mediational model was tested through an integrative, longitudinal structural equation paradigm applying LISREL analysis. More specifically, the integrative predictive structural equation model includes ten variables (see Figure 3, page 111): one enodogenous adjustment variable that, following previous research (Holahan & Moos, 1987), controlled for the influence of baseline adjustment on outcome adjustment as indexed by the residuals from the simple regressions of each of three observed outcome indicators (psychological, physical, and performance) on their respective indicator at baseline; three exogenous predictor variables (schedule demand, shiftwork locus of control, and spouse/partner social support); and an endogenous mediating latent variable (Adaptive Coping) indicated by the observed variables of approach and auxiliary coping.

Power Analyses

Sample size was highlighted earlier as an important component of ecological validity. Accordingly, to assist in drawing conclusions from analyses conducted in the present study, power analyses were performed to determine the likelihood of finding effects of interest.

This is important, since a test's power informs the experimenter about the probability of finding an effect if it does in fact exist given a particular sample size, alpha level, and desired population effect size (Cohen, 1977). Cohen (1977) suggests that .80 is adequate for most studies, but as power approaches .50 it approximates chance findings of 50%. Alpha (a measure of the probability that the population parameter effect size is in reality zero) is typically selected at .05, and all power analyses performed in the present study followed this convention. Moreover, Cohen (1977) suggests that .20, .50, and .80 respectively represent small, medium, and large effect sizes for empirical investigations in the social sciences.

Chapter 6: Results

Initially a series of preliminary analyses were conducted to both screen and composite data, including subject validity criteria, alpha reliability analyses, zero-order correlation matrices, Principal Components Analyses, and tests of normality, symmetry, equality of variance across groups, and expected versus observed data. Following preliminary analyses, zero-order correlations, means, and standard deviations were calculated for all primary study variables. Hypotheses were then tested using statistical tools including analyses of variance, covariance, and multiple regression, and power analyses were performed to determine the likelihood of finding significant effects of interest. Finally, structural equation and measurement models were analyzed using LISREL to test the integrative model and study the relationships among the multiple indicator and latent variables of interest in the current design.

PRELIMINARY ANALYSES

Variable Labels

Table 7 (page 185) summarizes the variable labels utilized in the present study's statistical analyses, as well as corresponding variable names and descriptions.

Table 7. Variable Labels, Names, and Descriptions

Label	Name	Description
Dmd	Demand	Schedule Demand (Alertness)
Ctrl	SHLOC	Shiftwork Locus of Control
Supp	Support	Spouse/Partner Support
AC	Adaptive Coping	Flexible coping: [(approach+auxiliary)/total]
AP	Approach Coping	Approach: [approach/(approach +avoidance)]
AX	Auxiliary Coping	Auxiliary: [auxiliary/(auxiliary+avoidance)]
Adj	Adjustment	zPsy + Phys + Perf
Psy	GHQ	General Health Questionnaire
Phys	Physical	zPHQ + ZMed
CvD	PHQ	Physical Health Questionnaire
Med	Medical	Medical Diagnosis, Standard Shiftwork Index
Perf	Performance	zSafe + zProd
Safe	Safety	Nodding/near accidents at work/driving
OSHA	OSHA	OSHA Recordable Cases, Incident Rate
Case	Case	Lost Workday Cases, Incident Rate
Acc	Acc	All Reported Accidents, Incident Rate
Day	Day	Lost Workdays, Severity Rate
OCA	OCA	zOSHA + zCase + zAcc
Prod	Productivity	Work errors/fatigue; sleep qual/quant work days
Proc	Comparative Productivity	Employee self-rating of productivity at follow up
Train	Training	Shiftwork Lifestyle Training
Pref	Schedule Preference	Schedule preference both initial and final selection
Age	Age	Age
YrS	Years Shiftwork	Years Shiftwork
Gen	Gender	Gender
Eth	Ethnicity	Ethnicity

Note. A “b” inserted at the beginning of a variable abbreviation indicates the baseline measure for the corresponding variable. A “z” inserted at the beginning of a variable indicates the z score transformation for the corresponding variable.

Reliability Alpha Coefficients

Table 8 summarizes reliability alpha coefficients for first order scales utilized in the present study (see Materials, page 154 for additional scale development background and reliability metrics). Broadly, the current study's reliability coefficients depicted in Table 8 indicated a moderately high mean reliability across study variables both at baseline (.82) and at follow-up (.84).

Table 8. Reliability Alpha Coefficients for First Order Study Scales

Scale	Number of Items	Pre	Post
General Health Questionnaire (GHQ)	12	.92	.93
Physical Health Questionnaire (PHQ)	19	.90	.92
Safety (Safe)	4	.64	.62
Productivity (Prod)	4	.68	.70
Schedule Demand (Dmd)	3	N/A*	.89
Shiftwork Locus of Control (SHLOC)	8	.86	.90
Adaptive Coping (AC)	18	.90	.91
Approach Coping (ApC)	8	.85	.86
Auxiliary Coping (AxC)	10	.82	.83

Note. Alpha coefficients represent present study reliabilities. Single-item measures not included (e.g., support, training, schedule preference follow-up comparative productivity).
*Assessed comparatively at time 2.

Composite Variables

To craft the present study's integrative model, composite variables were utilized (see Table 7: Variable Labels, Names, and Descriptions, page 185 and Figure 3: Hypothesized Structural Equation and Measurement Models, Page 111). Their use underscores an important a priori viewpoint: that variables such as adjustment (Adj) – the composite variable selected to broadly capture outcomes of interest at a global level – have in essence several dimensions, and that by combining these dimensions an enhanced assessment of the overall phenomenon of interest emerges. Accordingly, after confirming variable groupings based on both conceptual and empirical grounds, latent variables were constructed in the preliminary results that follow by summing z-score transformations as applicable to composite observed indicator variables.

Adjustment as Composite Latent Variable

Adjustment was initially conceptualized in the present study as a latent construct indicated by a composite measure of psychological health (PHQ); physical adjustment (Phys), including measures of cardiovascular and digestive health (PHQ) as well as medical diagnoses (Med); and operational performance (Perf), tapped by measures of productivity (Prod) and safety (Safe and OCA). Table 7, page 185 presents variable descriptions and relevant metrics.

A Principal Components Analysis, however, revealed that the OCA safety component did not fit well with other adjustment subscales and was therefore removed as in indicator of adjustment in the present study's predictive, integrative model. Specifically, Principal Components Analysis (PCA) using varimax rotation with Kaiser normalization setting factor extraction criteria at eigenvalues greater than one was applied iteratively to identify higher order factors connecting psychological, physical, and performance-related data. The extraction yielded two factors accounting for 66% of the variance in the six items. Five of the items (GHQ, PHQ, Med, Prod, and Safe) all loaded more highly on the first factor (.80, .83, .60, .81, and .77 respectively), while OCA loaded higher on the second factor (.96). Accordingly, the two-factor solution informed the decision to remove OCA from the current measure of Adjustment in the present study. Moreover, reliability analyses based on standardized items showed good internal consistency for the remaining measures of GHQ, Phys (PHQ and Med), and Perf (Prod and Safe) at Session 1 (α = .88) and adequate consistency at Session II (α = .79).

The determination to isolate the archival safety data also makes sense from a theoretical perspective, given relatively low safety incident rates in general. That is, safety risk can increase well before actual incidents occur, if at all, given protective safety redundancies often built into the work environment. Consider, for example, the automatic shut down of a freight train when a locomotive engineer continually fails to properly respond to an alerter signal or sustains excessive track speed. Similarly, a fatigued manufacturing employee may be unaware that he has drifted beyond the protective orange markings of a safety-sensitive factory floor, only to be abruptly reminded by the searing staccato of a forklift operator's horn.

Thus it is understandable that isolated, relatively low incident rates of reported safety occurrences – absent consideration of incalculable human and often substantial material and environmental costs of such occurrences – do not necessarily best predict risk (Lehrer, 2000) or adjustment, nor do they align with other adjustment indices of theoretical and empirical importance. Accordingly, archival safety records (OCA) were removed from adjustment based on both empirical and conceptual grounds. However, the archival data was retained for separate pre-post comparisons to add further texture to the present study's analyses.

Physical Adjustment as Indicator of Composite Adjustment

Physical adjustment was constructed as an indicator of the latent variable adjustment in the present model by compositing measures of physical health (PHQ) & diagnosed medical conditions since starting shiftwork (Med). As described previously (see Adjustment as Composite Latent Variable, page 187), both items loaded more highly on adjustment as one of two underlying factors extracted in a Principal Components Analysis.

Performance as Indicator of Adjustment

Performance was constructed as an indicator of the latent variable adjustment in the present study by compositing measures of productivity (Prod) and safety (Safe). As described previously (see Adjustment as Composite Latent Variable, page 187), both items loaded more highly on adjustment as one of two underlying factors extracted in a Principal Components Analysis.

Safety as Indicator of Performance

Initially, safety was conceived as an indicator of the latent variable Adjustment in the present study by compositing measures of safety risk (Safe) and archival safety records (OCA, see below). As described previously (see Adjustment as Composite Latent Variable, page 187), although Safe loaded more highly on adjustment as one of two underlying factors in a Principal Components Analysis, OCA loaded strongly on the second factor and was subsequently removed as an adjustment indicator on both conceptual and empirical grounds. Thus safety as an indicator of the latent variable adjustment was conceptualized in the present study as a measure of safety risk (Safe). The removed archival safety data is now further explored as a means of providing additional texture to the present study's analyses.

Archival Safety Measures

Archival safety data was operationalized as a composite measure of optimally related indices among the four measures tracking OSHA recordable cases, lost workday cases, total accidents, and days off. Empirically, the three-item grouping of OSHA recordable cases, lost workday cases, and total accidents produced greater reliability alpha coefficients (α = .81 pre- and .97 post-implementation) than resulted when including a measure of incident-related days off (e.g., baseline α = .60 versus .81 above). Conceptually this makes sense, as it seems reasonable that number of days off (i.e., recovery time) might be more susceptible than the other safety measures to a variety of external factors including motivation (e.g., psychological, social, financial) as well as biological predisposition to recovery.

Empirically, PCA using varimax rotation with Kaiser normalization setting factor extraction criteria at eigenvalues greater than one was applied iteratively to identify any higher order factors inherent in the archival safety data. The analysis yielded a two-factor solution that accounted for 82% of the variance in the 4 items. OSHA, cases, and accidents all loaded higher on factor one (.90, .84, .80, respectively), while days off loaded higher on factor two (.97). Accordingly, days off was dropped from the composite measure (OCA) based on both conceptual and empirical grounds. Days off severity rate was, however, retained for baseline and follow-up comparisons along with OSHA reportable, cases, and accident incident rates to add additional texture to the analyses (see Results, Archival Safety Statistics, page 221).

Productivity as Indicator of Performance

Productivity (Prod) was also conceived as an indicator of performance in the present study. As described previously (see Adjustment as Composite Latent Variable, page 187), the item loaded more highly on adjustment as one of two factors extracted in a Principal Components Analysis.

Comparative Job Productivity

A single survey item termed comparative job productivity (Proj) was also measured at follow-up (see Appendix C). To be consistent, it was not integrated directly into the composite follow-up adjustment measure as there was no corresponding identical baseline measure; however, it was deemed a useful comparative item that directly taps perceived employee productivity and was therefore retained for additional analyses to provide further texture and more fully inform the present study.

Coping Scales Defined

Coping responses were parsed in the present study into approach, auxiliary, and avoidant strategies conceptualized as first-order scales of interest developed using Carver's coping subscales (see Carver, Scheier, and Weintraub, 1989) and based on a priori hypotheses to further inform stress and coping processes beyond traditional partitioning into approach and avoidant strategies (see Broadened Coping Taxonomy, page 93).

Moreover, building on the present study's theoretical underpinnings for classifying coping responses (see page 171, Coping

Domains Defined), adaptive coping (flexibility) was operationalized as the breadth (quantity) and depth (degree) of both approach and auxiliary coping as a percentage score of total coping effort, calculated as follows:

Adaptive Coping (%) = (AP + AX)/(AP + AX + AV), where

AP = Mean Approach Coping score.

AX = Mean Axiliary Coping score.

AV = Mean Avoidance Coping score.

In addition, to specifically study distinctions between approach and auxiliary strategies, coping responses were also explored as isolated percentages of approach and auxiliary coping, defined as follows:

Approach Coping (%) = AP/(AP + AV)

Auxiliary Coping (%) = AX/(AX + AV)

To better integrate these measure into the present study's scoring format, where higher scores indicate potentially less adaptive levels of a particular variable in question, adaptive coping scores were subtracted from 1 so that higher scores indicate diminished levels of adaptive coping per the above formulas. Thus a score of 0 would indicate endorsement of only approach and/or auxiliary coping, whereas a score close to 1 would indicate largely avoidance coping.

Exploratory Data Screening Analyses

The robustness of the present study's data was explored by examining study variable metrics relating to normality, symmetry, equality of variance across groups, and expected versus observed data values. Exploratory procedures included histograms with normality curves, stem-and-leaf plots, boxplots, normal q-q plots of expected versus observed data, and Levene's test of equality of variance across groups. Broadly data appears relatively normal, with reasonable q-q plots. In instances where Levene's test of equality of variance across groups was not met, data transformations were performed including base 10 log, square root, squared, etc. Data transformations did not significantly affect homogeneity of variance.

Subsequently, to further explore these instances, Welch and Brown-Forsythe simulations were performed to calculate F statistics when homogeneity of variance is not assumed. These analyses resulted in no meaningful difference in significance as compared to standard ANOVA's, for example. That is, calculations yielded very similar or identical results as compared with those utilizing standard univariate and multivariate procedures. Thus, based on exploratory analyses addressing considerations of normality, symmetry, equality of variance, and expected versus observed data, results broadly supported the use of current variables of interest in the present study's longitudinal, integrative design.

DESCRIPTIVE STATISTICS

Tables 9 and 10 (pages 197 and 198) display the means, standard deviations, and zero-order correlations among primary study variables at baseline and follow-up, respectively. As described earlier in Chapter 5, the present study's measures include outcomes (i.e., adjustment – a composite measure of psychological health, physical health, and performance – as well as separate outcome measures including component adjustment indices, comparative productivity at follow-up, and archival safety records), a mediator (coping responses), modifiers (control and support), and predictive organizational systems (schedule demand, selection, and training). Although correlations do not imply causality, the categories of outcome, mediation, moderation, and organizational intervention are broadly utilized as a framework to present results concerning associations among primary study variables.

A word of caution is worth noting regarding the number of correlations performed (i.e., 324 correlations at follow-up) and results described in the following sections. As increasing pairs of variables undergo tests of bivariate correlation, the probability of drawing inaccurate conclusions increases (e.g., even at the .01 significance level, one might reasonably expect 1 out of 100 inaccurate conclusions of significance).

However, the patterns resulting from correlations performed in the present study do appear to demonstrate several consistencies (described below) among study variables tested, and therefore likely represent relatively robust assessments of correlation in the context of the current study's procedure and methodology (e.g., larger sample sizes also tend to more readily result in significance as compared to smaller sample sizes studying the same population and phenomenon). Note, Bonferroni adjusted pairwise comparisons are utilized later in the results when, for example, analyses of covariance were conducted with predictors having greater than two levels.

Correlations Relating to Intervention

Broadly, schedule demand showed significant moderate positive correlations with both outcome and predictive/moderating variables, and weak positive correlations with mediating auxiliary coping and the schedule preference intervention. Schedule preference generally showed significant weak positive correlations with other study variables, while shiftworker lifestyle training showed either no significant association or significant weak correlations with only a few study variables.

Correlations with Schedule Demand

As predicted, schedule demand and adjustment were positively associated, (r (436) = .60, $p < .01$); that is, schedule demand accounted for 36% of the variance in adjustment, a moderate effect. At a more specific level, scheduling demand was positively associated with multiple indicators of adjustment including psychological health (r (539) = .6, $p < .01$); physical health (r 455) = .35, $p < .01$); and operational performance

Table 9. Zero-Order Correlations, Means and Standard Deviations for Primary Study Variables at Baseline.

	bCtrl	bSupp	bCp	bApCp	bAxCp	bAdj	bPsy	bPhys	bCvDg	bMed	bPerf	bsafe	bOCA	bProd	M	SD
bCtrl	-	.218*	.165*	.115*	.191*	.494*	.466*	.359*	.423*	.216*	.426*	.304*	.103*	.454*	22.52	6.58
bSupp		-	.120*	.037	.171*	.433*	.416*	.319*	.370*	.190*	.316*	.209*	.014	.349*	2.04	1.14
bCp			-	.886*	.894*	.119*	.214*	.070	.116*	.059	.104*	.094*	.004	.092*	.63	.05
bApCp				-	.596*	.015	.100*	.013	.053	.025	.022	.001	-.012	.041	.46	.06
bAxCp					-	.197*	.289*	.111*	.157*	.084	.162*	.161*	.026	.129*	.46	.06
bAdj						-	.785*	.828*	.808*	.632*	.836*	.701*	.057	.775*	-.13	3.67
bPsy							-	.542*	.567*	.355*	.561*	.427*	.045	.565*	13.61	6.74
bPhys								-	.874*	.865*	.448*	.360*	.058	.437*	-.03	1.71
bCvDg									-	.514*	.504*	.383*	.052	.513*	11.75	9.48
bMed										-	.268*	.242*	.035	.237*	2.91	3.28
bPerf											-	.886*	.031	.886*	.00	1.77
bsafe												-	.029	.571*	6.75	3.11
bOCA													-	.022	.00	1.00
bProd														-	11.37	3.41

* .Correlation is significant at the 0.05 level (2-tailed). Note, many of the above correlations are significant at the .01 level (2-tailed) but are portrayed at the .05 level (2-tailed) to accommodate formatting constraints while allowing for single-page rendering. However, in the text describing these results, actual achieved significance levels (.05 or .01) are reported.

(r (548) = .62, $p < .01$). Interestingly, in the area of physical health, scheduling demand was more highly associated with cardiovascular and digestive symptomatology (r (508) = .46, $p < .01$) than with employee-reported actual medical diagnoses since beginning shiftwork (r (493) = .29, $p < .01$).

Regarding the composite variable of performance, demand was positively related to both safety and productivity components and showed

Table 10. Zero-Order Correlations, Means and Standard Deviations for Primary Study Variables at Follow-Up.

	Dmd	Ctrl	Supp	Cp	ApCp	AxCp	Adj	Psy	Phys	CvDg	Med	Perf	Safe	OCA	Prod	Proj	Train	Pref	M	SD
Dmd	-	.475*	.377*	.080	.040	.115*	.595*	.557*	.352*	.460*	.213*	.620*	.475*	.061	.609*	.768*	-.005	.347*	9.62	2.55
Ctrl		-	.378*	.196*	.179*	.184*	.619*	.568*	.491*	.504*	.379*	.551*	.405*	.087*	.570*	.461*	.042	.223*	22.54	6.67
Supp			-	.161*	.069	.228*	.561*	.544*	.447*	.461*	.354*	.489*	.404*	.023	.469*	.355*	-.025	.173*	1.66	.95
Cp				-	.904*	.896*	.206*	.216*	.125*	.068	.135*	.157*	.167*	-.171*	.112*	.073	.092*	-.047	.63	.05
ApCp					-	.628*	.116*	.120*	.071	.043	.083	.096*	.114*	-.137*	.060	.028	.073	-.030	.47	.05
AxCp						-	.286*	.281*	.181*	.109*	.178*	.225*	.231*	-.176*	.165*	.117*	.092*	-.023	.46	.06
Adj							-	.784*	.846*	.828*	.657*	.869*	.761*	.031	.795*	.549*	-.073	.285*	-.25	3.75
Psy								-	.540*	.621*	.336*	.607*	.471*	.036	.611*	.522*	-.036	.239*	13.03	6.87
Phys									-	.869*	.877*	.531*	.470*	.065	.487*	.348*	-.095*	.187*	-.06	1.71
CvDg										-	.524*	.573*	.461*	.027	.563*	.424*	-.097*	.213*	13.03	10.41
Med											-	.366*	.342*	.086*	.311*	.228*	-.066	.123*	2.11	3.27
Perf												-	.890*	.010	.890*	.520*	-.050	.271*	-.01	1.78
Safe													-	-.017	.585*	.404*	-.058	.168*	7.02	3.25
OCA														-	.038	.042	-.021	.035	.00	1.00
Prod															-	.506*	-.039	.312*	11.57	3.51
Proj																-	-.009	.318*	3.08	.83
Train																	-	-.047	1.48	.50
Pref																		-	.42	.49

* .Correlation is significant at the 0.05 level (2-tailed). Note, many of the above correlations are significant at the .01 level (2-tailed) but are portrayed at the .05 level (2-tailed) to accommodate formatting constraints while allowing for single-page rendering. However, in the text describing these results, actual achieved significance levels (.05 or .01) are reported.

a stronger relationship with productivity ($r(554) = .61$, $p < .01$) as compared to safety ($r(551) = .48$, $p < .01$). Interestingly, employee perception of comparative productivity (Proj) yielded the strongest positive correlation with schedule demand ($r(559) = .77$, $p < .01$).

Considering associations between schedule demand and other intervention components, demand did not show a significant association with shiftworker lifestyle training but was positively associated with schedule selection preference ($r (551) = .35, p < .01$). As well, significant positive associations with demand were found for the moderating and predictive variables of both shiftwork locus of control ($r (538) =.48, p < .01$) and spouse/partner support ($r (494) = .38, p < .01$.

Examining associations between demand and coping responses, particularly interesting was the finding that although demand was not significantly correlated with either adaptive or approach coping, it was slightly yet positively associated with auxiliary coping ($r (482) = .12, p < .05$). Moreover, the pattern of finding positive significant associations – albeit modest – between auxiliary coping and several other study variables while finding less (if any) significance between adaptive coping and other study variables and no significance between approach coping and a number of other study variables was broadly replicated in the present study. Such findings suggest the potential importance of auxiliary coping as a theoretically distinct and empirically important coping strategy (see Tables 9 and 10, pages 197-198).

Correlations with Schedule Selection Preference

As predicted, schedule selection preference was positively associated with adjustment ($r (462) = .29, p < .01$), as well as with components of adjustment including psychological health ($r (570) = .24, p < .01$), physical health ($r (481) = .19, p < .01$), and its components cardiovascular/digestive symptomatology ($r (536) = .21, p < .01$) and employee-reported medical diagnoses ($r (522) = .12, p < .01$), performance ($r (583) = .27, p < .01$) and its components safety ($r (587) = .17, p < .01$) and productivity ($r (587) = .31, p < .01$). Moreover, schedule preference was positively associated with comparative productivity at follow-up ($r (591) = .32, p < .01$).

Regarding other intervention components, schedule selection preference was positively associated with demand as previously noted but was not associated with shiftworker lifestyle training. In terms of associations with study moderators, preference was positively associated with both shiftwork locus of control ($r (572) = .22, p < .01$) and spouse/partner support ($r (519) = .17, p < .01$). Considering relationships with coping as a mediator, schedule preference showed no significant association.

Correlations with Shiftworker Lifestyle Training

Among the primary study variables noted above, shiftworker lifestyle training showed weak positive associations with adaptive coping ($r (504) = .09, p < .05$) and auxiliary coping ($r (514) = .09, p < .05$), but not with approach coping or other primary study variables. Interestingly, training showed slightly negative associations with both physical adjustment ($r (484) = -.09, p < .05$) and its cardiovascular/digestive component ($r (541) = -.10, p < .05$).

Correlations Relating to Mediation

Broadly, adaptive coping and the present study's partitioned components of approach and auxiliary coping demonstrated distinct and discernible patterns of association with other study variables. Auxiliary coping, as compared to adaptive and approach strategies, typically showed stronger positive associations with other study variables, falling in the weak to weak-moderate range. Adaptive coping generally yielded weak correlations with other study variables, while approach coping typically produced either no association or very weak associations with other variables.

Given that one theoretical underpinning of the present design aims to study auxiliary coping as a distinct and important coping response set, it was not surprising that while approach and auxiliary coping were both strongly associated with an overall measure of adaptive coping – which by definition tapped both approach ($r\ (506) = .90,\ p < .01$) and auxiliary components ($r\ (506) = .90,\ p < .01$) – approach and auxiliary strategies themselves were less although still moderately related ($r\ (506) = .63,\ p < .01$). Thus, while approach and auxiliary coping each account for approximately 39% of variance in the other – a moderate effect – there remains significant variance in each variable not explained directly by the other, suggesting that unique dimensions of each contribute to distinct mechanisms of action.

Correlations with Adaptive Coping

Adaptive coping was weakly but positively associated with overall adjustment (r (406) = .21, $p < .01$), psychological health (r (487) .22, $p < .01$), physical health (r (423) = .13, $p < .05$) and its component employee-reported medical diagnoses (r (450) = .14, $p < .01$) but not cardiovascular/digestive symptomatology, performance (r (498) = .16, $p < .01$) and its components safety (r (501) = .17, $p < .01$) and productivity (r (502) = .11, $p < .05$). Adaptive coping was not associated with a measure of comparative productivity at follow-up but was positively related to shiftwork locus of control (r (491) = .20, $p < .01$) and spouse/partner support (r (439) = .16, $p < .01$). As well, adaptive coping (flexibility) showed a weak association with shiftwoker lifestyle training as noted previously.

Correlations with Approach Coping

Approach coping was very weakly associated with overall adjustment (r (436) = .12, $p < .05$) and psychological health (r (531) .12, $p < .01$), and not associated with either physical health or its components cardiovascular/digestive symptomatology and employee-reported medical diagnoses. Approach coping was also very weakly related to performance (r (543) = .10, $p < .05$) and its safety component (r (546) = .11, $p < .01$) but to neither its productivity component nor a separate measure of comparative productivity at follow-up. Approach coping was related to shiftwork locus of control (r (533) = .18, $p < .01$) but to neither spouse/partner support nor shiftwoker lifestyle training. Overall, these findings present a significantly weaker pattern of association as compared to relationships detected between auxiliary coping and other study variables as described below.

Correlations with Auxiliary Coping

As predicted, auxiliary coping was positively associated with overall adjustment (r (412) = .29, p < .01) and accounted for over 8% of the variance in adjustment, a small to small-moderate effect. Moreover, auxiliary coping was positively associated with adjustment components including psychological health (r (498) .28, p < .01), physical adjustment (r (430) = .18, p < .01) and its components cardiovascular/digestive symptomatology (r (477) = .11, p < .05) and employee-reported medical diagnoses (r (460) = .18, p < .01), and performance (r (507) = .23, p < .01) and its components safety (r (511) = .23, p < .01) and productivity (r (512) = .17, p < .01).

Moreover, auxiliary coping was also positively related to a measure of comparative productivity at follow-up (r (515) = .12, p < .01), and to shiftwork locus of control (r (502) = .18, p < .01) and spouse/partner support (r (448) = .23, p < .01). As well, auxiliary coping was associated with shiftwoker lifestyle training as noted previously (r (514) = .09, p < .05).

Correlations Relating to Moderation and Prediction

Broadly, shiftwork locus of control showed moderate associations with schedule demand and outcome variables, and weak associations with mediating coping variables and schedule preference, while showing no association with training. At a general level, spouse/partner support showed moderate associations with schedule demand and outcome variables, weak associations with schedule preference as well as mediating auxiliary and adaptive coping, and no association with either approach coping or training.

Correlations with Shiftwork Locus of Control

As predicted, shiftwork locus of control was positively associated with adjustment ($r(457) = .62$, $p < .01$), accounting for approximately 38% of the variance in adjustment, a moderate effect. Shiftwork locus of control was also positively associated with psychological health ($r(561) = .57$, $p < .01$), physical health ($r(476) = .49$, $p < .01$), and its components cardiovascular/digestive symptomatology ($r(528) = .50$, $p < .01$) and employee-reported medical diagnoses ($r(515) = .38$, $p < .01$), performance ($r(570) = .55$, $p < .01$) and its components safety ($r(573) = .41$, $p < .01$) and productivity ($r(576) = .57$, $p < .01$).

Moreover, shiftwork locus of control was positively associated with comparative productivity at follow-up ($r(577) = .46$, $p < .01$). As noted previously, shiftwork locus of control was also positively associated with schedule demand, schedule preference, and coping response sets including adaptive, approach and auxiliary coping. Shiftwork locus of control was also associated with spouse/partner support ($r(504) = .38$, $p < .01$) but not with shiftworker lifestyle training.

Correlations with Spouse/Partner Social Support

As predicted, spouse/partner support was positively associated with demand ($r\ (494) = .38,\ p < .01$) and shiftworker locus of control as noted above ($r\ (504) = .38,\ p < .01$), accounting for more than 14% of the variance in demand and more than 14% of the variance in shiftworker locus of control, both somewhat moderate effects. Given an aim of the present study to integrate spouse/partner support in a broadened and refined conceptualization of Karasek's (1979) original demand-control model of stress and strain, these results are important as they suggest underlying relationships between support, demand, and control, while still allowing for unique dimensions of spouse/partner support not accounted for by either demand or control.

As also predicted, spouse/partner support was positively associated with adjustment ($r\ (409) = .56,\ p < .01$), accounting for 31% of the variance in adjustment, a moderate effect. As well, spouse/partner support was positively associated with components of adjustment including psychological health ($r\ (503) = .54,\ p < .01$), physical health ($r\ (428) = .45,\ p < .01$), including cardiovascular/digestive ($r\ (479) = .46,\ p < .01$) and medical diagnoses components ($r\ (461) = .35,\ p < .01$), and performance ($r\ (515) = .49,\ p < .01$), including component safety ($r\ (518) = .40,\ p < .01$) and productivity ($r\ (521) = .47,\ p < .01$). Moreover, spouse/partner support was positively associated with comparative productivity at follow-up ($r\ (523) = .36,\ p < .01$), but not with training.

TESTS OF HYPOTHESES

To compare differences in adjustment outcomes, predictors, mediating paths, and moderating indicators predicted by the present study's longitudinal, integrative model (see Figures 2 and 3, pages 110 and 111, respectively), a series of GLM univariate procedures were conducted including analyses of variance (ANOVA) and covariance (ANCOVA), simple linear regression, and multiple linear regression (MLR).

To facilitate the analyses, several variables functioning as predictors were parsed by median split into two subgroups: those whose scores fell at or below the median, and those whose scores fell above it. Specifically, these variables included schedule demand, adaptive coping, approach coping, auxiliary coping, and shiftwork locus of control.

Significant results reported in the analyses that follow were in the direction predicted by the present study's hypotheses (see pages 132 – 137) except as specifically noted in one instance. To interpret effect sizes, Cohen (1988) suggested some general definitions for the social sciences as a whole, labeling the magnitude of effects sizes small when mean level differences ($d = (\mu1 - \mu2)/\sigma$) = .20, medium when d = .5, and large when d = .80. These broad classifications are general guidelines, however, and will be further discussed in the next chapter.

Power analyses were also performed for tested samples to determine the probability of finding effects of interest. To assist with efforts to replicate study findings, power analyses for significant relationships among primary study variables are presented in Table 29 (Appendix C, page 393). Power analyses for non-significant findings are presented along with corresponding test results for hypotheses 1 though 10.

Predicting Adjustment: Intervention Effects Relating to Hypotheses 1 and 2

Following previous research (Holahan & Moos, 1987), all ANCOVAs conducted in this section controlled for the effect of baseline adjustment on adjustment at follow-up. Applying this methodology, a series of ANCOVAs were conducted to explore differences in adjustment outcomes predicted by intervention components aiming to minimize schedule demand, accommodate schedule preferences, and provide proactive shiftwork lifestyle training (see Hypotheses 1 and 2, pages 132-133). More specifically, ANCOVAS tested unique and combined effects of demand, preference and training on individual and composite measures of adjustment including indices of psychological health, physical health, and operational performance.

Schedule demand, preference, and training functioned as independent variables, each parsed into high and low groups with schedule demand defined by median split (see page 206). Adjustment outcomes served as dependent variables, and corresponding baseline adjustment measures functioned as covariates. Adjustment outcomes (see Table 7: Variable Labels, Names, and Descriptions, page 185) included a composite measure of adjustment as well as composite and component indices of psychological health (GQH), physical adjustment (PHQ & Med), and operational performance (Prod & Safe), as well as a follow-up comparative measure of productivity (Proc).

Composite Measure of Adjustment

Main Effects

ANCOVAs were conducted and showed a significant main effect for schedule demand on adjustment at follow-up ($F(1, 368) = 99.90$, $p < .001$), after controlling for the effect of adjustment at baseline ($F(1, 368) = 144.26$, $p < .001$). More specifically, adjustment was significantly better in the low stress group ($M = -2.11$, $SD = 2.49$) as compared to the high stress group ($M = 2.28$, $SD = 4.03$), with 1.14 SD separating the average scores, a relatively large effect size suggesting that employees functioning with greater levels of schedule-related stress as tapped by diminished alertness tended to experience poorer overall adjustment. Table 11, page 209, displays adjustment means, standard deviations, and sample sizes across intervention component indices and subgroupings.

Similarly, a main effect was found for schedule selection preference on overall adjustment ($F(1, 368) = 8.42$, $p < .01$) after controlling for the significant effect of adjustment at baseline as noted above. Specifically, those employees able to work a schedule most preferred among employee-based, data-driven options (see Table 12, page 210) showed better overall adjustment ($M = -1.15$, $SD = 3.67$) than those employees working a schedule not most preferred during at least one of two evaluation rounds as part of the schedule selection process (M = .93, SD = 3.82). Standard deviations were comparable for preference subgroups, and mean differences were greater than .5 SD, suggesting a moderate effect.

Shiftworker lifestyle training (see Table 13, page 210 for attendance data) produced no significant main effect on composite adjustment (F (1, 368) = 1.20, p =.27). Average adjustment for those employees that attended

Table 11. Means and Standard Deviations: Adjustment as a Function of Demand, SchedulePreference, and Training, Controlling for Adjustment at Baseline

Dependent Variable: Adj

sDmd	Pref	Train	Mean	Std. Deviation	N
Low stress	Preferred schedule	Emp attended training	-2.25448	2.64810132	81
		Emp did not attend training	-2.37906	2.29027195	88
		Total	-2.31935	2.46160388	169
	Not preferred schedule	Emp attended training	-1.48762	2.54751458	31
		Emp did not attend training	-1.48525	2.50903162	25
		Total	-1.48656	2.50737365	56
	Total	Emp attended training	-2.04222	2.63188099	112
		Emp did not attend training	-2.18132	2.35846596	113
		Total	-2.11208	2.49369495	225
High stress	Preferred schedule	Emp attended training	2.415296	4.14550590	34
		Emp did not attend training	1.641819	4.88474955	27
		Total	2.072937	4.46560167	61
	Not preferred schedule	Emp attended training	2.590761	3.52022953	54
		Emp did not attend training	2.163402	4.05103835	37
		Total	2.417000	3.72913398	91
	Total	Emp attended training	2.522968	3.75167615	88
		Emp did not attend training	1.943359	4.39230854	64
		Total	2.278922	4.03001873	152
Total	Preferred schedule	Emp attended training	-.8738508	3.80481362	115
		Emp did not attend training	-1.43503	3.51782359	115
		Total	-1.15444	3.66691841	230
	Not preferred schedule	Emp attended training	1.103351	3.74650329	85
		Emp did not attend training	.6921705	3.92657040	62
		Total	.9299278	3.81561729	147
	Total	Emp attended training	-.0335401	3.89591307	200
		Emp did not attend training	-.6899081	3.79408332	177
		Total	-.3417023	3.85730695	377

training (M = -.03, SD = 3.90) was .17 SD higher than for those not attending (M = -.69, SD = 3.79), yielding poorer mean adjustment, but not significantly so, although the power to detect differences was low at .20.

Table 12. Employee Schedule Selection Results

Work Group	Schedule Selected	Votes For	Votes Against	Total Votes	% For
Fabrication Technician	3-2-2-3	495	474	969	51.08%
Senior Fabrication Technician	2-5-5-2	153	116	269	56.88%
Primary Technician	6-2	167	45	212	78.77%
Senior Primary Technician	2-5-5-2	48	17	65	73.85%
Electrical Technician	2-5-5-2	59	10	69	85.51%
Parts	6-2	20	0	20	100%
Supply	2-5-5-2	51	42	93	54.84%
Shipping	3-2-2-3	53	9	62	85.48%
TOTAL		1046	713	1759	59.47

Note. 3-2-2-3 and 2-5-5-2 refer to repeating 12-hour fixed shift patterns of days or nights (e.g., 3-2-2-3 represents three 12-hr day shifts on, two days off, two 12-hour day shifts on, three days off, etc.). 6-2 refers to a repeating 8-hour fixed shift pattern of either days, evenings, or nights (e.g., six 8-hour night shifts on, two days off, six 8-hour night shifts on, two days off, etc.).

Table 13. Shiftworker Lifestyle Training Attendance Results

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes, attended with partner	100	16.6	16.7	16.7
	yes, attended, does not have partner	79	13.1	13.2	29.9
	yes, attended without partner	135	22.4	22.5	52.4
	did not attend	285	47.3	47.6	100.0
	Total	599	99.3	100.0	
Missing	System	4	.7		
Total		603	100.0		

Note. Spouse/partner attendance was not interpreted in the present study as an indicator of support due, anecdotally, to a large number of employees unable to be accompanied by their spouse/partner due to conflicting childcare or employment responsibilities. Spouse/partner support was instead tapped via employee survey.

Interactions

ANCOVAs, controlling for adjustment at baseline, yielded no significant interaction effects for the four intervention predictor combinations (demand/preference, demand/training, preference/training, demand/preference/training). However, the power to detect differences was low at .14, .19, .06, .19, respectively; thus these findings might reasonably be questioned particularly in light of additional exploratory data. Interestingly, despite not realizing significance at α = .05, visual inspection of the relationships, for example, among the low stress group across subgroups of preference and training (F (1, 368) = 1.20, p = .28), suggests the possibility of a modest interaction when exploring model-predicted estimated marginal mean plots (Figure 4).

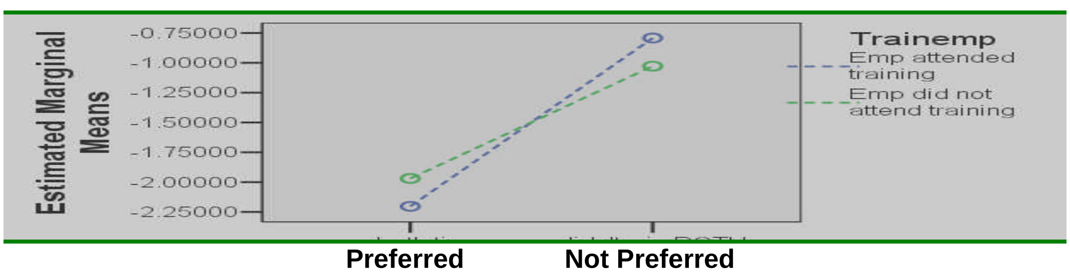


Figure 4. Adjustment as a Function of Schedule Preference & Shiftworker Lifestyle Training for the Low Stress Demand Subgroup.

Specifically, the estimated marginal means of adjustment predicted by the model suggested that for the low stress group and when the schedule was preferred, employees attending training (M = -2. 20, SE = .30) had approximately .78 SE better mean scores for adjustment than those employees who did not attend training (M = -1.97, SE = .29), while a smaller outcome occurred in the reverse direction when the schedule was not preferred; that is, employees with training (M= -.79, SE = .49) had approximately .46 SE poorer mean scores for adjustment than those without training (M = -1.03, SE = .55) in the low stress group. This suggests that the effects of training may better facilitate improved stress resistance and adjustment outcomes in the context of relatively low employee schedule demand when an employee perceives the work schedule as most preferred among several alternative options, espousing a benefit of employee-driven schedule selection on biopsychosocial adaptation.

Psychological Adjustment

Main Effects

Parsing adjustment into its component indices, ANCOVAs were conducted and a significant main effect was found for schedule demand on psychological adjustment as tapped by the GHQ at follow up ($F(1, 497) = 135.53$, $p < .001$) after controlling for the effect of psychological adjustment at baseline ($F(1, 497) = 62.91$, $p < .001$). Psychological adjustment was significantly better in the low stress group (M = 9.92, SD = 4.14) as compared to the high stress group (M = 17.43, SD = 7.59), with 1.09 SD separating the average scores, suggesting that employees with greater levels of schedule-related stress as measured by diminished alertness tended to experience poorer overall psychological health.

No significant main effect was found for schedule selection preference on psychological adjustment ($F(1, 497) = 3.53$, $p = .06$) after controlling for the significant effect of adjustment at baseline, although the arbitrary, albeit standard predetermined alpha cutoff of $p = .05$ just precluded significance at $p = .06$. Moreover, those employees able to work a schedule most preferred among employee-based, data-driven options as previously described showed better overall adjustment ($M = 11.66$, $SD = 6.67$) than those employees working a less desired schedule ($M = 15.03$, $SD = 6.74$).

Thus, standard deviations were highly comparable for preference subgroups, and subgroup means showed differences of .49 SD, a basically moderate effect size per Cohen (1988) and just shy of statistical significance but with observed power to detect such differences at only .47, suggesting that perhaps with greater sample cell sizes a statistically significant difference might have emerged. For all practical purposes, however, the current results suggest a reasonable, albeit statistically nonsignificant, relationship between preference and psychological adjustment in the direction predicted by the current study's hypotheses.

Shiftworker lifestyle training produced no significant main effect on psychological adjustment ($F(1, 368) = 0.795$, $p = .37$). Standard deviations were comparable for both training subgroups, and average psychological adjustment for those attending training ($M = 13.16$, $SD = 7.00$) and those not attending training (M = 12.89, SD = 6.79) only differed by .04 SD, although the power to detect significant differences was only .14.

Interactions

No significant interaction effects were found for the four intervention predictor combinations of demand/preference, demand/training, preference/training, or demand/preference/training. For example, a test of the combined effect of demand and training on psychological adjustment (F (1, 497) = 2.73, p = .10) yielded no significant interaction. However, the power to detect differences was low at .19, .38, .31, .31, respectively.

Physical Adjustment

Main Effects

A significant main effect was found for schedule demand on physical adjustment at follow-up (F (1, 393) = 36.21, $p < .001$), after controlling for the effect of physical adjustment at baseline (F (1, 393) = 115.19, $p < .001$). More specifically, physical adjustment (tapped via the composite measure of PHQ and Med; see Table 7: Variable Labels, Names, and Descriptions, page 185) was significantly better in the low stress group (M = -.68, SD = 1.38) as compared to the high stress group (M = .71, SD = 1.82), with approximately .87 SD difference between the average scores, suggesting that employees with greater levels of schedule demand as measured by diminished alertness tended to experience poorer overall physical adjustment.

No main effect was found for schedule selection preference on physical adjustment (F (1, 393) = 3.29, p = .07) after controlling for the significant effect of physical adjustment at baseline as noted above. Although those employees able to work a preferred schedule exhibited better overall physical adjustment (M = -.39, SD = 1.64) than those employees working a schedule not most preferred (M = .32, SD = 1.75), with relatively comparable standard deviations and a difference of over .4 SD between groups, the difference fell shy of statistical significance in the context of a moderately low observed power of .44.

Shiftworker lifestyle training produced no significant main effect on physical adjustment (F (1, 393) = .87, p = .35). Standard deviations were comparable for both training subgroups, and average adjustment for those attending training (M = .04, SD = 1.75) was only approximately .19 SD different than for those not attending training (M = -.28, SD = 1.67). The power to detect significant differences however was low at .15.

Interactions

ANCOVAs yielded no significant interaction effects for the four intervention predictor combinations including demand/preference, demand/training, preference/training, or demand/preference/training, with F statistics yielding alpha probability levels at or above .47. However, the power to detect differences was low at .07, .06, .05, .11, respectively.

Physical Health

Main Effects

Further parsing the index of physical adjustment into its components of physical health (PHQ) and medical diagnoses (Med), a significant main effect was found for schedule demand on physical health (PHQ) at follow-up ($F_{(1, 444)} = 70.84$, $p < .001$), after controlling for the effect of physical health at baseline ($F_{(1, 444)} = 149.66$ $p < .001$). More specifically, physical health as tapped via the PHQ was significantly better in the low stress group ($M = 8.47$, $SD = 7.90$) as compared to the high stress group ($M = 18.54$, $SD = 10.76$), with approximately one standard deviation separating the average scores, suggesting that employees with greater levels of schedule-related stress as measured by diminished alertness tended to experience poorer physical health.

A significant main effect was also found for schedule selection preference on physical health ($F_{(1, 444)} = 5.00$, $p < .05$) after controlling for the significant effect of physical health at baseline as noted above. Specifically, those employees able to work a preferred schedule showed better physical health in terms of cardiovascular and digestive symptomatology ($M = 10.76$, $SD = 10.16$) than those employees working a schedule not most desired ($M = 15.55$, $SD = 10.28$), with comparable standard deviations and a difference of approximately .47 SD between groups.

Shiftworker lifestyle training yielded no significant main effect on physical health ($F_{(1, 444)} = .86$, $p = .35$). Standard deviations were relatively comparable for both training subgroups, and average physical health for those attending training ($M = 13.74$, $SD = 10.95$) was only approximately .2 SD different than for those not attending training ($M = 11.61$, $SD = 9.80$). The power to detect significant differences however was low at .15.

Interactions

ANCOVAs yielded no significant interaction effects for the four intervention predictor combinations, with F statistics yielding alpha probability levels at or above .12. For example, although both demand and preference showed unique main effects on physical health, a test of their combined effect was not significant ($F(1, 444) = 1.14$, $p = .29$). However, the power to detect differences was low across predictor combinations, at or below .34.

Medical Diagnoses

Main Effects

ANCOVAs were conducted and showed a significant main effect for schedule demand on the medical diagnoses component of physical adjustment at follow-up ($F(1, 464) = 14.24$, $p < .001$), after controlling for the effect of medical diagnoses at baseline ($F(1, 464) = 74.19$, $p < .001$). More specifically, adjustment was significantly better in the low stress group ($M = 1.40$, $SD = 2.90$) as compared to the high stress group ($M = 3.01$, $SD = 3.44$), with approximately .5 SD separating the average scores, suggesting that employees with greater levels of schedule-related stress as measured by diminished alertness tended to experience an increased number of medical diagnoses since beginning shiftwork.

No main effect was found for either schedule selection preference ($F (1, 464) = .42$, $p = .51$) or training ($F (1, 464) = 1.07$, $p = .30$) on medical diagnoses after controlling for the significant effect of medical diagnoses at baseline as noted above, with low power to detect differences at .10 and .18 respectively.

Interactions

ANCOVAs yielded no significant interaction effects for the four intervention predictor combinations on medical diagnoses since starting shiftwork. For example, a test of the combined effect of preference and training on medical diagnoses was not significant ($F (1, 464) = 2.39$, $p = .12$). However, the power to detect differences across predictor combinations was low at or less than .30.

Operational Performance

Main Effects

ANCOVAs were conducted and a significant main effect was found for schedule demand on operational performance at follow-up ($F (1, 520) = 183.91$, $p < .001$), after controlling for the effect of operational performance at baseline ($F (1, 520) = 106.10$, $p < .001$). Specifically, operational performance (tapped via a composite measure of safety (Safe) and productivity (Prod); see Table 7: Variable Labels, Names, and Descriptions, page 185) was significantly better in the low stress group ($M = -.89$, $SD =$

1.24) as compared to the high stress group (M = 1.19, SD = 1.70), with approximately 1.4 SD separating the mean scores, suggesting that employees with greater levels of schedule-related stress as measured by diminished alertness were significantly more likely to demonstrate poorer operational performance.

As well, a significant main effect was found for schedule selection preference on operational performance ($F (1, 520) = 11.58$, $p < .001$) after controlling for the significant effect of operational performance at baseline as noted above. Specifically, those employees able to work a preferred schedule were more likely to deliver better operational performance (M = -.40, SD = 1.70) than those employees working a schedule not most desired (M = .61, SD = 1.75). With standard deviations comparable for preference subgroups, their means showed differences of approximately .59 SD.

Shiftworker lifestyle training showed no significant main effect on operational performance ($F (1, 520) = .31$, $p =.58$), although the power to detect significant differences was low at .09.

Interactions

ANCOVAs yielded no significant interaction effects for the four intervention predictor combinations. For example, a test of the combined effect of demand, preference, and training on operational performance was not significant ($F (1, 520) = 1.76$, $p = .19$). However, the power to detect differences across predictor combinations was low at or less than .26.

Safety

Main Effects

Further parsing the present study's index of operational performance into its components of safety (Safe) and productivity (Prod), a significant main effect was found for schedule demand on safety (Safe) at follow-up ($F(1, 527) = 100.30$, $p < .001$), after controlling for the effect of safety at baseline ($F(1, 527) = 107.37$, $p < .001$). More specifically, safety – as tapped via survey items comprising the Safe scale – was significantly better in the low stress group ($M = 5.74$, $SD = 2.22$) as compared to the high stress group ($M = 8.75$, $SD = 3.64$), with an average of approximately one standard deviation separating the average scores, suggesting that employees with greater levels of schedule-related stress as measured by diminished alertness tended to experience greater risk for safety incidences.

No significant main effect was found for either schedule selection preference ($F(1, 527) = .64$, $p = .43$) or shiftworker lifestyle training on safety ($F(1, 527) = .85$, $p = .36$) after controlling for the significant effect of safety at baseline as noted above. The power to detect differences was low, however, at .13 and .15, respectively.

Interactions

ANCOVAs yielded no significant interaction effects for the four intervention predictor combinations, with F statistics yielding alpha probability levels at or above .09. For example, a test of the combined effect of demand, preference, and training was not significant ($F(1, 527) = 2.86$, $p = .09$). However, the power to detect differences was low across predictor combinations, with observed power at or below .39.

Archival Safety Statistics

Archival safety records including OSHA reportable cases, lost workday cases, all reported accidents, and lost workdays were determined for each of eight functional work group classifications at the production site participating in the present study after first obtaining and compositing further partitioned subgroup safety data through the organization's corporate Environmental Health & Safety and Medical departments. This compilation process assured that shiftworker safety records were isolated from extraneous employee safety data, and that only those work groups participating in the present study were assessed. Once established by work classification, these safety records were then composited into a single measure for each of the four safety indices (i.e., OSHA, Case, Accs, and Days) for a period of twelve months prior to (e.g., bOSHA) and twenty-four months post (e.g., OSHA) scheduling and training initiatives (see Table 14, page 223).

Because corporate safety data statistics were archived for external reference according to job function, only work group classifications, once established, could be assigned a group safety score, not affording for individual variation by shiftworker within the same work group. Accordingly, it is understandable that correlations among OCA (a composite measure of OSHA, Case, and Accs) and other study variables of interest were poor given the absence of true OCA variation reflected within a work classification (Table 10: Zero-Order Correlations, Means and Standard Deviations for Primary Study Variables at Follow-Up, page 198).

That is, regardless of how individuals varied not only in terms of schedule demand, spouse/partner support, overall adjustment, etc., but also in safety behavior and performance, all employees in the same functional work group were assigned identical OSHA-related safety statistics in the present study for their particular site and work group in question. Thus, it is important and meaningful to examine shiftworker differences in pre-post OSHA-related safety measures by safety indice to inform actual changes in shiftworker plant safety over time, as presented in Table 14.

To test overall improvements to shiftworker site safety, paired sample t-tests were conducted for the four archival safety measures including OSHA reportable cases (OSHA), lost workday cases (Case), all reported accidents (Accs) and lost workdays (Days). As Table 15 depicts,

Table 14. Archival Safety Data Descriptive Statistics: OSHA Reportable Cases, Lost Workday Cases, All Reported Accidents, and Lost Workdays.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
bOSHA	597	.00	13.00	5.8008	1.40506
OSHA	590	1.63	8.57	4.3096	1.67468
bCase	597	.00	13.00	3.4775	1.29245
Case	592	.00	6.31	2.8022	1.56797
bAccs	597	.00	52.00	27.9941	7.52922
Accs	592	4.90	34.72	16.7898	6.28486
bDays	597	.00	2014.99	444.0910	524.23216
Days	592	.00	971.59	315.4571	278.37925
Valid N (listwise)	584				

results yielded significant differences in the anticipated direction for all four tests, with all indices demonstrating better safety results at follow-up.

More specifically, employees had fewer OSHA reportable cases at follow-up as evidenced by a decreased incidence rate (M = 1.48, SD = 1.88) than at baseline (t (583) = 19.07, p < .001). In other words, at follow-up there were an average of 1.48 fewer OSHA reportable cases for every 100 employees over the course of a year. Similarly, the sample workforce had

Table 15. Results of Archival Safety Data Pre-Post Comparisons: OSHA Reportable Cases, Lost Workday Cases, All Reported Accidents, and Lost Workdays.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	bOSHA - OSHA	1.47982	1.87561	.07761	1.32738	1.63226	19.067	583	.000
Pair 2	bCase - Case	.66950	2.15536	.08904	.49463	.84437	7.519	585	.000
Pair 3	bAccs - Accs	11.10821	8.07042	.33339	10.45343	11.76299	33.319	585	.000
Pair 4	bDays - Days	128.9442	569.19293	23.51314	82.76373	175.1246	5.484	585	.000

fewer lost workday cases per 100 employees per year at follow-up (M = .67, SD = 2.16) as compared to baseline (t (585) = 7.52, p < .001), as well as averaging over 11 fewer total accidents per year per 100 employees at follow-up (M = 11.11, SD = 8.07) versus baseline (t (585) = 33.32, p < .001). Finally, shiftworkers in the present study averaged fewer accident-related days off at follow-up as evidenced by a decreased severity rate (M = 128.94, SD = 569.19) as compared to baseline (t (585) = 5.48, p < .001). That is, shiftworkers took an average of 128.94 fewer related days off per year per 100 employees at follow-up.

Interestingly, these results compare favorably with OSHA incident rates of nonfatal occupational injuries and illnesses by industry and case type (OSHA, 2003) for the specific manufacturing group studied. Specifically, the overall 2003 OSHA recordable incident rate for this NAICS code (North American Industry Classification System Manual, 2002 Edition) was 9.6 as compared to present study results of 5.8 at baseline and 4.3 at follow-up. As well, the 2003 incident rate for lost workday cases for this specific NAICS code was 3.3 as compared to 3.5 at baseline and 2.8 at follow-up, moving from above to below the norm in the present study.

Productivity

Main Effects

ANCOVAs were conducted and showed a significant main effect for schedule demand on the productivity component of operational performance at follow-up (F (1, 527) = 179.17, p < .001), after controlling for the effect of productivity at baseline ($F(1, 527) = 74.64$, $p < .001$). Specifically, productivity – as tapped via survey items comprising the Prod scale – was significantly better in the low stress group ($M = 9.82$, $SD = 2.82$) as compared to the high stress group ($M = 13.86$, $SD = 2.90$). The two groups had comparable standard deviations, but a mean difference of 1.41 SD. Thus, employees with greater levels of schedule-related stress as measured by diminished alertness were significantly more likely to achieve poorer levels of productivity.

As well, a significant main effect was found for schedule selection preference on productivity ($F(1, 527) = 23.88$, $p < .001$) after controlling for the significant effect of productivity at baseline as noted above. Specifically, those employees able to work a preferred schedule were more likely to realize greater levels of productivity ($M = 10.66$, $SD = 3.41$) than those employees not working their most preferred schedule ($M = 12.88$, $SD = 3.16$**),** with an average of approximately .67 SD separating the average scores, suggesting that employees working a preferred schedule tended to achieve greater levels of productivity.

Shiftworker lifestyle training showed no significant main effect on productivity ($F(1, 527) = .002$, $p = .97$), although the power to detect significant differences was low at .05.

Interactions

ANCOVAs yielded no significant interaction effects for the four intervention predictor combinations. For example, a test of an interaction effect among demand, preference, and training on operational performance was not significant ($F(1, 527) = .27$, $p = .61$). However, the power to detect differences across predictor combinations was low at or below .10.

Comparative Productivity at Follow-up

Main Effects

A measure of comparative productivity was tapped during Survey Session II to assess employee perception of productivity (Proc) at follow-up versus baseline, adding texture in addition to the indice of productivity integrated as part of the composite measure of adjustment. ANOVAs were conducted and showed a significant main effect for schedule demand on comparative productivity at follow-up ($F(1, 540) = 217.35$, $p < .001$). More specifically, employee-perceived productivity was significantly better in the low stress group ($M = 2.67$, $SD = .63$) as compared to the high stress group ($M = 3.67$, $SD = .73$). The two groups had comparable standard deviations, but a mean productivity difference of almost 1.5 SD. Thus, employees with greater levels of schedule-related stress as measured by diminished alertness were significantly more likely to be less productive on the job at follow-up.

As well, a significant main effect was found for schedule selection preference on comparative productivity at follow-up ($F(1, 540) = 12.36$, $p < .001$). Specifically, those employees able to work a preferred schedule were more likely to realize greater levels of productivity ($M = 2.88$, SD

= .86) than those employees not working their most preferred schedule (M = 3.41, SD = .70**),** with an average of approximately .68 SD separating the mean productivity scores, suggesting that employees working a preferred schedule tended to achieve greater levels of productivity at follow-up.

Shiftworker lifestyle training showed no significant main effect on productivity (F (1, 540) = .39, p = .53), although the power to detect significant differences was low at .10.

Interactions

ANOVAs yielded a significant interaction for the combined effect of schedule demand and preference on productivity (F (1, 540) = 12.30, p < .001), displayed graphically using model-predicted estimated marginal mean plots (see Figure 5, page 228). Power to detect differences among nonsignificant predictor combinations was low at or below .06.

Specifically regarding the significant demand-preference interaction predicting productivity at follow-up, descriptive statistics demonstrate that in the high schedule demand group – as tapped via reduced alertness – schedule preference did not affect productivity; in fact, mean productivity was essentially identical in both the preferred (M = 3.67**,** SD = .81) and nonpreferred subgroups (M = 3.66, SD = .67). In the low stress group, however, those employees working preferred schedules experienced significantly better perceived productivity at follow-up (M = 2.55, SD = .63), than those employees working nonpreferred schedules (M=2.98, SE = .51), a difference of approximately .75 SD.

These findings suggest that implementation of a preferred schedule in a data-driven, employee-centric selection process facilitates improved on-the-job productivity in the context of lower, more manageable levels of employee schedule demand. When stress levels remain relatively high, however, schedule preference does not appear to provide the same buffering effects toward optimizing productivity. This underscores the value of working a shift schedule that appears to decrease employee stress over time while also allowing employees to select the schedule.

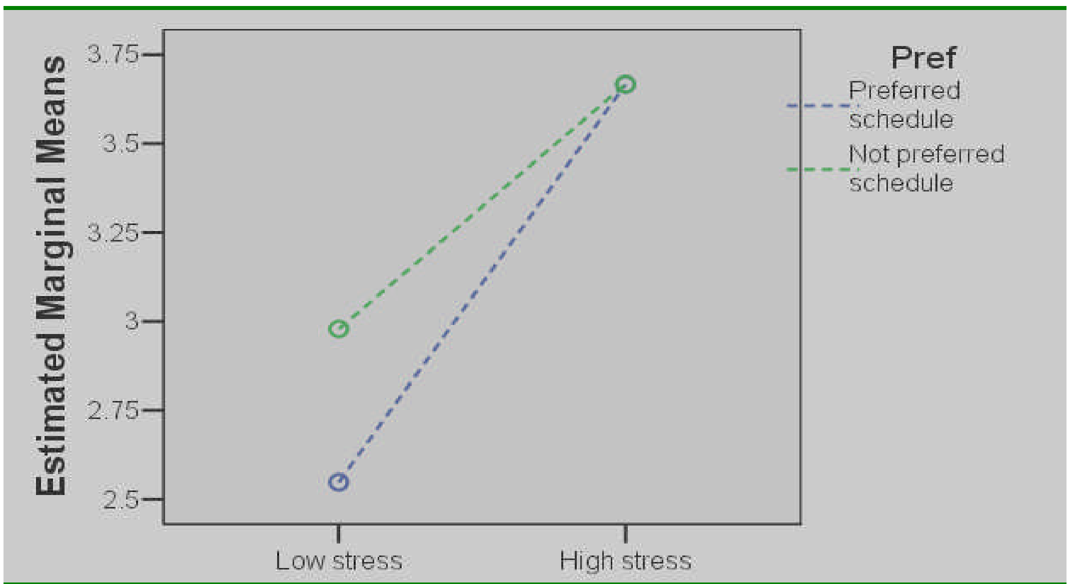


Figure 5. Interaction of Schedule Demand and Schedule Preference on Comparative Productivity.

Summary of Results Relating to Hypotheses 1 and 2

Results relating to the effects of intervention (e.g., schedule demand, schedule preference and shiftworker lifestyle training) on composite adjustment and its component indices after controlling for corresponding adjustment indices at baseline included significant main effects for schedule demand on all adjustment indices in the present study including: composite adjustment (Adj), psychological adjustment (GHQ), physical adjustment (Phys), physical health (PHQ), medical diagnoses (Med), operational performance (Perf), safety (Safe), and productivity (Prod), as well as an additional measure of comparative productivity at follow-up (Proc).

Significant main effects were also found for schedule preference on composite adjustment (Adj), physical health (PHQ), performance (Perf), productivity (Prod), and comparative productivity (Proc). Findings also showed a significant interaction effect for demand and preference on both productivity (Prod) and comparative productivity (Proc). No main effects were found for training on adjustment indices, nor was training involved in interaction effects relating to adjustment measures in the present study.

Finally, tests of pre-post comparisons of archival shiftworker safety data found significant differences in the predicted direction for all four safety indices (i.e., OSHA, Case, Accs, Days), showing better safety results at follow-up.

Predicting Control & Support: Intervention Effects Relating to Hypothesis 3

A series of ANCOVAs were conducted to explore differences in shiftwork locus of control and spouse/partner social support predicted by the intervention components of schedule preference and shiftworker lifestyle training (see Hypothesis 3, page 133). ANCOVAS tested unique and combined effects of schedule preference and training. Schedule preference and training functioned as independent variables, each with two levels. Control and support outcomes served as dependent variables, with corresponding control and support measures at baseline functioning as covariates.

Shiftwork Locus of Control

ANCOVAs were conducted and a significant main effect was found for schedule preference on shiftwork locus of control at follow up ($F(1, 555) = 29.76$, $p < .001$) after controlling for the effect of shiftwork locus of control at baseline ($F(1, 555) = 59.56$, $p < .001$). More specifically, those employees able to work a preferred schedule were more likely to have greater levels of internal shiftwork locus of control ($M = 21.20$, $SD = 6.60$) than those employees working a schedule not most preferred ($M = 24.31$, $SD = 6.23$). Standard deviations were comparable for preference subgroups, and subgroup means showed differences of approximately .48 SD, suggesting that employees able to work a preferred shift schedule tended to experience greater internal control.

No significant main effect was found for training on shiftwork locus of control ($F(1, 555) = 1.91$, $p = .17$), nor was there evidence of any interaction between schedule preference and training on shiftwork locus of control. However, the observed power to detect differences was low, at .28 and .05, respectively.

Spouse/Partner Social Support

ANCOVAs were conducted and a significant main effect was found for schedule preference on spouse/partner social support at follow up ($F(1, 482) = 20.30$, $p < .001$) after controlling for the effect of spouse/partner social support at baseline ($F(1, 482) = 46.02$, $p < .001$). More specifically, those employees able to work a preferred schedule were more likely to have greater levels of perceived support from their spouse or partner ($M = 1.52$, $SD = .90$) than those employees working a schedule not most preferred ($M = 1.86$, $SD = .96$). Standard deviations were comparable for preference subgroups, and their means showed differences of approximately .36 SD, suggesting that employees able to work a preferred shift schedule tended to experience somewhat greater spouse/partner support.

No main effect was found for training on spouse/partner support ($F(1, 482) = .02$, $p = .90$), nor was there evidence of any interaction between schedule preference and training on support. However, the observed power to detect differences in both tests was low at .05.

Summary of Results Relating to Hypothesis 3

Results described above relating to the effects of intervention including schedule preference and training on shiftwork locus of control and spouse/partner support showed significant main effects for schedule preference on both control and support. No main effects were found for training on either control or support, nor were interaction effects observed between preference and training.

Coping as Mediator: Adaptive, Approach, and Auxiliary Effects Relating to Hypotheses 4 through 7

A series of ANCOVAs were conducted to explore predicted mediating roles of coping in predicting adjustment (see Hypotheses 4 through 7, pages 134 and 135) as illustrated in the present study's path analytic and measurement models (see Figures 2 and 3, pages 110 and 111, respectively). More specifically, ANCOVAS were conducted to examine main and interaction effects of approach and auxiliary coping. Additional ANCOVAs also tested the effect of a composite measure of adaptive coping (see Table 7: Variable Labels, Names, and Descriptions, page 185).

Moreover, when coping variables were input as fixed factors in GLM Univariate ANCOVA, each coping variable was parsed into two subgroups defined by median split as previously described (see page 206). When coping variables were instead entered as continuous dependent variables in additional analyses, covariates of interest were addressed following previous research (Holahan & Moos, 1987) by simultaneously controlling for corresponding measures of coping at baseline. Similarly, when adjustment outcomes at follow-up were entered as DV's, corresponding adjustment measures at baseline were input as covariates.

Composite Measure of Adjustment

ANCOVAs were conducted and as predicted (see Hypothesis 4, page 134) a significant main effect was found for auxiliary coping on adjustment at follow-up ($F(1, 350) = 4.68$, $p < .05$), after controlling for the effect of adjustment at baseline ($F(1, 350) = 138.69$, $p < .001$). Interestingly, contrary to predictions, no significant main effects were found for either approach coping ($F(1, 350) = .04$, $p = .84$) or adaptive coping ($F(1, 352) = 2.31$, $p = .13$) after controlling for adjustment at baseline, nor was there an observed interaction between approach and auxiliary coping ($F(1, 350) = .01$, $p = .91$), although the power to identify differences was .33 for adaptive and .06 for approach coping.

More specifically regarding auxiliary coping, adjustment was significantly better in the high auxiliary group ($M = -.86$, $SD = 3.04$) as compared to the low auxiliary group ($M = .18$, $SD = 4.6$), with approximately .27 SD separating the average scores, suggesting that employees implementing greater auxiliary coping responses in terms of increased breadth and/or depth were more likely to demonstrate better composite adjustment, although the effect size is relatively small (Cohen , 1988).

Additional Measures of Adjustment

Parsing adjustment into its component indices, ANCOVAs were conducted to more specifically explore the effects of coping strategies on component dimensions including psychological health (GQH), physical health (PHQ & Med), and operational performance (Prod & Safe), as well as a follow-up comparative measure of productivity (Proc); see Table 7: Variable Labels, Names, and Descriptions, page 185. ANCOVAs simultaneously controlled for corresponding measures of adjustment at baseline. Results of significance are reported below.

ANCOVAs produced a significant main effect for auxiliary coping on psychological adjustment (as tapped by the GHQ) at follow up ($F(1, 463) = 8.08$, $p < .01$), after controlling for the effect of psychological adjustment at baseline ($F(1, 463) = 52.60$, $p < .001$). Psychological adjustment was significantly better in the high auxiliary group ($M = 12.06$, $SD = 5.68$) as compared to the low auxiliary group ($M = 13.99$, $SD = 7.90$), with approximately .28 SD separating the average scores, indicating that employees sampling more actively from auxiliary coping strategies tended to experience better overall psychological health.

A significant main effect was also found for adaptive coping on psychological adjustment ($F(1, 465) = 4.13$, $p < .05$) after controlling for the effect of psychological adjustment at baseline ($F(1, 465) = 54.33$, $p < .001$). Psychological adjustment was significantly better in the high adaptive group ($M = 12.30$, $SD = 6.00$) as compared to the low auxiliary group ($M = 13.77$, $SD = 7.73$), with approximately .21 SD separating the average scores, suggesting that employees showing more adaptive coping tended to experience better overall psychological health. The power to identify these differences was .53. No main effect was found for approach coping, nor was there an interaction effect between approach and auxiliary coping.

A significant main effect was found for auxiliary coping on operational performance as tapped by the present study's composite performance scale (perf), (F (1, 484) = 6.68 $p \leq .01$) after controlling for the effect of operational performance at baseline (F (1, 484) = 92.48, $p < .001$). Performance was significantly better in the high adaptive group (M = -.25, SD = 1.56) as compared to the low auxiliary group (M = 1.89, SD = 1.95), with approximately .25 SD separating the average scores, suggesting that employees using more auxiliary coping tended to perform better on the job. No main effect was found for the composite measure of adaptive coping or for approach coping, nor was there an interaction effect between approach and auxiliary coping.

A significant main effect was found for auxiliary coping on safety as tapped by the present study's Safe scale, (F (1, 491) = 6.44 $p \leq .05$) after controlling for the effect of safety at baseline (F (1, 491) = 114.69, $p < .001$). Performance was significantly better in the high auxiliary group (M = 6.53, SD = 2.90) as compared to the low auxiliary group (M = 7.43, SD = 3.61), with approximately .27 SD separating the average scores, suggesting that employees implementing more auxiliary coping tended to better manage safety risk. No main effect was found for approach coping, nor was there an interaction effect between approach and auxiliary coping.

A significant main effect was also found for the composite measure of adaptive coping on safety (Safe), (F (1, 493) = 7.66 p < .01) after controlling for the effect of safety at baseline (F (1, 493) = 115.67, p < .001). Safety was significantly better in the high adaptive group (M = 6.52, SD = 2.76) as compared to the low auxiliary group (M = 7.47, SD = 3.73), with .29 SD separating the average scores, suggesting that employees showing more adaptive coping tended to better manage safety risk.

Summary of Results Relating to Hypothesis 4

Results described above relating to coping's effect on adjustment included a significant main effect for auxiliary coping on the present study's composite measure of adjustment. Furthermore, significant main effects were also found for auxiliary coping on psychological adjustment, safety, and operational performance, as well as significant main effects for the composite measure of adaptive coping on psychological adjustment and safety. No main effects were found for approach coping, nor were interaction effects observed between approach and auxiliary coping.

Intervention Effects

A series of ANCOVAs were conducted to explore differences in coping responses predicted by the intervention components of schedule demand, schedule preferences, and shiftworker lifestyle training (see Hypotheses 5 and 6, pages 134-135). More specifically, ANCOVAS tested unique and combined effects of schedule demand, preference and training on a composite measure of adaptive coping as well as unique measures of approach and auxiliary coping. Moreover, ANCOVAs addressed covariates of interest in the present study by simultaneously controlling for corresponding measures of coping at baseline.

Schedule demand, preference, and training were input as independent variables, each parsed into two groups with schedule demand defined by median split (see page 206). Coping measures at follow-up were entered as dependent variables, with corresponding indices of coping at baseline functioning as covariates (see Table 7: Variable Labels, Names, and Descriptions, page 185 for related scale construction metrics).

ANCOVAs were conducted and showed a significant main effect for schedule demand on auxiliary coping at follow-up ($F (1, 427) = 6.91$, $p < .01$), after controlling for the effect of auxiliary coping at baseline ($F (1, 427) = 113.76$, $p < .001$). More specifically, employees showed more auxiliary coping in the low stress group ($M = .46$, $SD = .05$) as compared to the high stress group ($M = .47$, $SD = .07$), with .22 SD separating the average scores, suggesting that employees with greater levels of schedule-related stress as measured by diminished alertness tended to utilize less auxiliary coping.

A main effect was found for schedule demand on the composite measure of adaptive coping at follow-up ($F (1, 409) = 4.09$, $p < .05$), after controlling for the effect of adaptive coping at baseline ($F (1, 409) = 117.13$, $p < .001$). More specifically, employees showed more adaptive coping in the low stress group ($M = .63$, $SD = .04$) as compared to the high stress group ($M = .64$, $SD = .05$), with .14 SD separating the average scores, suggesting that employees with greater levels of schedule-related stress as measured by diminished alertness tended to utilize more adaptive coping, although the effect size is quite low.

A significant main effect was also found, but in an opposing direction to hypothesized predictions, for schedule selection preference on adaptive coping at follow-up ($F (1, 409) = 5.24$, $p < .05$) after controlling for the effect of adaptive coping at baseline as noted above. Specifically, those employees able to work a preferred schedule showed less adaptive coping ($M = .64$, $SD = .04$) than those employees working a schedule not most preferred ($M = .63$, $SD = .05$), with differences of approximately .11 SD suggesting a very low effect size.

Summary of Results Relating to Hypotheses 5 and 6

Results described above relating to the effects of intervention including schedule demand, preference, and training on coping responses showed significant main effects for schedule demand on both auxiliary coping and adaptive coping. A significant main effect was also found for schedule preference on adaptive coping, but in a direction contrary to that predicted. None of the interventions showed a main effect on approach coping. As well, no main effects were identified for training nor were any interaction effects observed among the interventions.

Separate Statistical Tests for Mediation

To explore coping's mediating role in predicting intervention effects on adjustment in the present study, four conditions required testing as described by Baron and Kenny (1986) and depicted in Figure 6.

A.	Predictor	→	Mediator
B.	Predictor	→	DV
C.	Mediator	→	DV
D.	(Predictor	impact	DV, Controlling for Mediator) < B

Figure 6. Four Conditions Required for a Variable to Demonstrate Mediation (Adapted from Baron & Kenny, 1986). Note, "→" indicates a significant association.

In the context of the current study's design, the four requirements of mediation with respect to schedule demand effects on adjustment are depicted in Figure 7:

A.	Intervention	⟶	Coping
B.	Intervention	⟶	Adjustment
C.	Coping	⟶	Adjustment
D.	(Intervention	impact	Adjustment, Controlling for Coping) < B

Figure 7. Four Conditions Required for Coping to Demonstrate Mediation in the Present Study with Respect to Intervention (Adapted from Baron & Kenny, 1986). Note, "→" indicates a significant association.

Requirements A, B, and C were previously tested (see Summary of Results Relating to Hypotheses 5 and 6, page 238; Hypotheses 1 and 2, page 228; and Hypothesis 4, page 236, respectively). These results identified six potential mediating effects of coping that met the first three requirements of mediation (Baron and Kenny, 1986), including auxiliary coping as a mediator between schedule demand and adjustment as well as adjustment's component indices of psychological health, safety, and performance, and adaptive coping as a mediator between schedule demand and psychological health and safety. Neither schedule preference nor training satisfied all three initial criteria A, B, and C; therefore, they were not tested with respect to criteria D.

For the six schedule demand-related instances where mediation requirements A, B, and C were satisfied, a series of ANCOVAs were conducted to test condition D – that the impact of intervention on adjustment after controlling for coping was less than the significant association between intervention and adjustment without controlling for coping (see Hypothesis 7, page 135) – by comparing differences in adjustment at follow-up predicted by schedule demand after controlling for coping as well as corresponding measures of adjustment at baseline to address covariates of interest in the current integrative design, and by then comparing these effects to differences in adjustment predicted by schedule demand without controlling for coping.

A series of ANCOVAs were conducted with schedule demand input as the independent variable, parsed into high and low stress groups defined by median split (see page 206). Coping measures were input as covariates, and adjustment measures at follow-up were entered as dependent variables with corresponding indices of baseline adjustment also entered as covariates. Comparison runs were then made for each possible mediating effect by removing coping as a covariate.

Auxiliary Coping as Mediator

ANCOVAs showed a significant main effect for schedule demand on the present study's composite measure of adjustment (Adj) at follow-up ($F\ (1, 335) = 138.44$, $p < .001$) after controlling for the effects of auxiliary coping ($F\ (1, 335) = 32.66$, $p < .001$) and baseline adjustment ($F\ (1, 335 = 108.83$, $p < .001$). As predicted, ANCOVAs conducted without controlling for the mediating effects of auxiliary coping found a greater main effect for schedule demand on adjustment ($F\ (1, 379) = 151.41$, $p < .001$), after controlling for adjustment at baseline ($F\ (1, 379) = 128.\ 55$, $p < .001$). These results suggest that auxiliary coping operates as a partial mediator in the relationship between schedule demand and adjustment.

Along the same lines, a main effect found for schedule demand on psychological health (GHQ) ($F\ (1, 513) = 191.12$) at follow-up after controlling for the effects of psychological health at baseline ($F\ (1, 513) = 61.65$, $p < .001$) was greater than the main effect found for schedule demand on psychological health ($F\ (1, 443) = 186.35$) at follow-up after controlling for the effects of auxiliary coping ($F(1, 443) = 39.84$, $p < .001$) and baseline psychological adjustment ($F(1, 443) = 37.21$, $p < .001$), supporting auxiliary coping's mediating role in predicting the effect of schedule demand on psychological health.

Similarly, in separate ANCOVAs, main effects found for schedule demand on safety (Safe) and operational performance (Perf) at follow-up ($F(1, 542) = 129.52$, $p < .001$); ($F(1, 535) = 263.26$, $p < .001$), respectively, after controlling for the effects of safety and operational performance at baseline ($F(1, 542) = 106.57$, $p < .001$); ($F(1, 535) = 94.87$, $p < .001$), were greater than the main effects found for schedule demand on safety and operational performance ($F(1, 467) = 108.69$, $p < .001$); ($F(1, 461) = 224.57$, $p < .001$), at follow-up after controlling for the effects of auxiliary coping ($F(1, 467) = 14.62$, $p < .001$); ($F(1, 461) = 16.45$, $p < .001$) and controlling for baseline safety and operational performance ($F(1, 467) = 92.65$, $p < .001$); ($F(1, 461) = 77.23$, $p < .001$). These findings support auxiliary coping's mediating role in predicting the effects of schedule demand on both safety and performance.

Adaptive Coping as Mediator

To test adaptive coping's mediating role, separate ANCOVAs were conducted and found that main effects for schedule demand on psychological health (GHQ) and safety (Safe) ($F(1, 513) = 191.12$, $p < .001$); ($F(1, 542) = 129.52$, $p < .001$), respectively, at follow-up after controlling for the effects of psychological health and safety at baseline ($F(1, 513) = 61.65$,

$p < .001$); (F (1, 542) = 106.57, $p < .001$) were greater than the main effects found for schedule demand on psychological health and safety (F (1, 433) = 181.25, $p < .001$); (F (1, 458) = 103.78, $p < .001$), at follow-up after controlling for the effects of auxiliary coping (F (1, 433) = 30.77, $p < .001$); (F (1, 458) = 7.57, $p < .01$), and baseline psychological health and safety (F (1, 433) = 41.63, $p < .001$); (F (1, 458) = 91.19, $p < .001$). These results suggest that adaptive coping operates as a partial mediator in the relationship between schedule demand and psychological health as well as between schedule demand and safety.

Summary or Results Relating to Hypothesis 7

ANCOVAs were conducted and identified six paths of mediation between the present study's interventions and adjustment outcomes, each satisfying the four requirements as described by Baron and Kenny (1986). Four paths involved auxiliary coping mediating the relationships between schedule demand and adjustment, psychological health, safety, and performance indices, while two additional paths involved adaptive coping's mediating role between schedule demand and both psychological health and safety (see Figure 8).

Predicting Adjustment: Control and Support Effects Relating to Hypothesis 8

It is important and meaningful to better understand the relationships among spouse/partner support, shiftwork locus of control, and adjustment outcomes, particularly when considering an expanded demand-control-support framework to conceptualize stress processes (see

Barton, 1995; Karasek, 1979; Astrand et al., 1989; Falk et al., 1992; Johnson & Hall, 1989). Accordingly, to explore differences in adjustment predicted

1. Schedule Demand ⟶ Auxiliary Coping ⟶ Adjustment
2. Schedule Demand ⟶ Auxiliary Coping ⟶ Psychological Health
3. Schedule Demand ⟶ Auxiliary Coping ⟶ Safety
4. Schedule Demand ⟶ Auxiliary Coping ⟶ Performance
5. Schedule Demand ⟶ Adaptive Coping⟶ Psychological Health
6. Schedule Demand ⟶ Adaptive Coping ⟶ Safety

Figure 8. Auxiliary and Adaptive Coping as Mediators Between Intervention and Adjustment Indices

by control and support variables (see Hypothesis 8, page 136), a series of ANCOVAs were conducted controlling for adjustment at baseline to test both unique and combined effects of shiftwork locus of control and spouse/partner support on adjustment. Control had two levels defined by median split (see page 206) and support had four levels, ranging from no problem to major problem (see page 168). Adjustment served as the dependent variable, with adjustment at baseline entered as the covariate. To further examine the effects of shiftwork locus of control and spouse/partner support on different dimensions of adjustment, a series of ANOVAs and ANCOVAs were conducted to explore differences in adjustment indices in an effort to add important and meaningful texture to the overall composite measure of adjustment.

More specifically, ANOVAs and ANCOVAS were used to test unique and combined effects on adjustment measures including psychological adjustment (GHQ), physical adjustment (Phys) and its component indices of physical health (PHQ) and medical diagnoses (Med) since starting shiftwork, as well as operational performance (Perf) and its component indices of safety (Safe) and productivity (Prod). ANCOVAs addressed covariates of interest in the present study by simultaneously controlling for corresponding measures of adjustment at baseline. Effects on a measure of comparative productivity (Proc) at follow-up was also tested to assess operational performance using an additional employee-centric productivity measure (see Table 7: Variable Labels, Names, and Descriptions, page 185, for scale construction metrics).

Composite Measure of Adjustment

Main Effects

ANCOVAs were conducted and showed as predicted a significant main effect for shiftwork locus of control on adjustment at follow-up ($F(1, 342) = 48.47$, $p < .001$), after controlling for the effect of adjustment at baseline ($F(1, 342) = 84.00$, $p < .001$). More specifically, adjustment was significantly better in the high internal control group ($M = -1.95$, $SD = 2.68$) as compared to the low internal control group ($M = 1.51$, $SD = 4.11$), with approximately .91 SD separating their average scores, suggesting that employees with higher levels of internal shiftwork locus of control experienced better overall adjustment.

Similarly, as predicted a significant main effect was found for support on overall adjustment ($F (3, 342) = 33.48, p < .01$) after controlling for the effect of adjustment at baseline as noted above. Specifically, those employees who thought that their spouse's/partner's level of understanding and emotional support was not a problem showed better overall adjustment ($M = -1.73, SD = 2.74$) than those employees reporting spouse/partner support levels as a slight problem ($M = .59, SD = 3.20$), a moderate problem ($M = 3.38, SD = 4.21$), or a major problem ($M = 5.65, SD = 4.98$), with adjustment becoming progressively worse as support diminished.

Moreover, Bonferroni adjusted pairwise comparisons of support levels on adjustment based on estimated marginal means (see Table 16) showed significant differences in the predicted directions for all but one of the six possible pairings; only the single comparison between "moderate problem" and "major problem" did not produce significance. Pairwise comparison of "slight problem" and "moderate problem" was significant at $p < .01$; the remaining four comparisons were all significant at $p < .001$.

Interactions

ANCOVAs yielded a significant interaction between support and control on adjustment ($F (3, 342) = 3.85, p = .01$), displayed graphically using model-predicted estimated marginal mean plots (see Figure 9, page 248). The buffering effect of high internal shiftwork locus of control was significantly influenced by the degree of spouse/partner support.

Table 16. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Adjustment

Pairwise Comparisons

Dependent Variable: Adj

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
no problem	slight problem	-1.537*	.352	.000	-2.470	-.603
	moderate problem	-3.533*	.554	.000	-5.004	-2.062
	major problem	-5.066*	.627	.000	-6.729	-3.402
slight problem	no problem	1.537*	.352	.000	.603	2.470
	moderate problem	-1.996*	.603	.006	-3.596	-.396
	major problem	-3.529*	.669	.000	-5.306	-1.753
moderate problem	no problem	3.533*	.554	.000	2.062	5.004
	slight problem	1.996*	.603	.006	.396	3.596
	major problem	-1.533	.786	.312	-3.620	.554
major problem	no problem	5.066*	.627	.000	3.402	6.729
	slight problem	3.529*	.669	.000	1.753	5.306
	moderate problem	1.533	.786	.312	-.554	3.620

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

More specifically, whereas descriptive statistics confirmed as predicted, that for each of the four levels of spouse/partner support, employees in the high internal shiftwork locus of control group showed better overall adjustment than those in the corresponding low internal group, the buffering effect of high internal control was especially pronounced when spouse/partner support was perceived to be a major problem (M = 1.63, SD = 3.12) as compared to the low internal control group (M = 7.66, SD = 4.55), with an average difference between the subgroups of approximately 1.59 SD. Thus for spouse/partner relationships that were reported as significantly problematic in terms of employee-perceived support, lower internal shiftwork locus of control yielded significantly and disproportionately poorer adjustment.

Moreover, employees reporting no spouse/partner support problems within the high internal control group (M = -2.55, SD = 2.23) had an average adjustment score of .55 SD better than those reporting a slight problem, (M = -1.09, SD = 2.44), 1.63 SD better than those reporting a moderate problem (M = 1.82, SD = 4.01), and 1.56 SD better than those indicating a major problem (M = 1.63, SD = 3.12), with those employees reporting better spouse/partner support and indicating high internal shiftwork locus of control having the greatest overall adjustment.

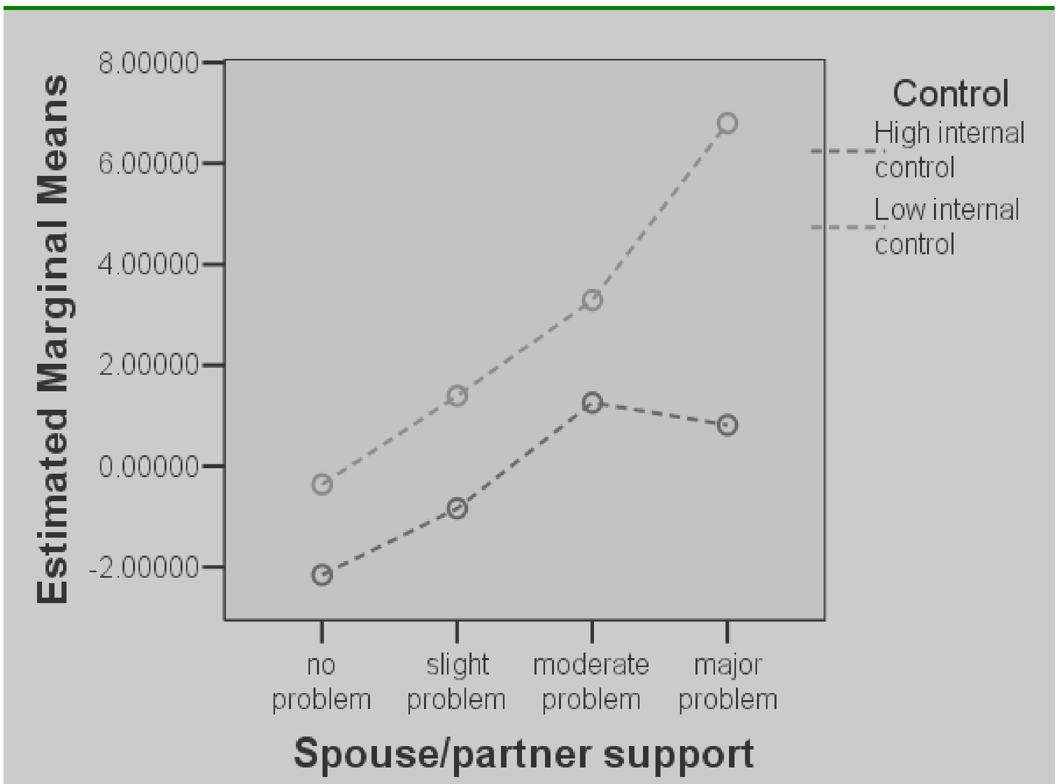


Figure 9. Interaction of Spouse/Partner Social Support and Shiftwork Locus of Control on Adjustment.

These findings indicate that better levels of spouse/partner support successively facilitate better adjustment in the context of low internal shiftwork locus of control, and that for the high internal control group, better levels of spouse/partner support facilitate successively better adjustment for the no problem, slight problem, and moderate problem support subgroups. As support problems progress from moderate to major, the buffering effect of high internal control is further enhanced yielding significantly increased divergence between high and low control effects on adjustment as illustrated in Figure 9. This underscores the combined value of both greater levels of spouse/partner support and higher internal levels of shiftwork locus of control in predicting adjustment.

Psychological Adjustment

Additional ANCOVAs were conducted and showed a significant main effect for shiftwork locus of control on psychological adjustment as tapped in the present study through a measure of psychological health (GHQ) at follow-up ($F(1, 458) = 47.92$, $p < .001$), after controlling for the effect of psychological health at baseline ($F(1, 458) = 31.34$, $p < .001$). More specifically, adjustment was significantly better in the high internal control group ($M = 10.30$, $SD = 4.75$) as compared to the low internal control group ($M = 16.05$, $SD = 7.68$), with approximately .83 SD separating their average scores, suggesting that employees with higher levels of internal shiftwork locus of control experienced better overall psychological health.

Similarly, a significant main effect was found for support on psychological health ($F (3, 458) = 38.12, p < .001$) after controlling for the effect of psychological health at baseline as noted above. Specifically, those employees with no reported problems concerning perceived spouse/partner support tended to have better psychological health ($M = 10.49, SD = 4.85$) than those employees reporting spouse/partner support levels as a slight problem ($M = 14.04, SD = 5.56$), a moderate problem ($M = 19.68, SD = 8.23$), or a major problem ($M = 22.25, SD = 9.08$), with psychological health becoming progressively worse overall as support diminished.

Moreover, Bonferroni adjusted pairwise comparisons of support levels on psychological health based on estimated marginal means (see Table 17) showed significant differences ($p < .001$) in the predicted directions for all but one of the six possible pairings; only the single comparison between “moderate problem” and “major problem” did not yield significance.

ANCOVAs also found a significant interaction between support and control on psychological health ($F (3, 458) = 3.93, p < .01$). The interaction – comparable to that found between support and control on overall adjustment – is displayed using estimated marginal mean plots (see Figure 10, page 251). As with the interaction effect on adjustment, the buffering effect of high internal shiftwork locus of control on psychological health was significantly related to the degree of spouse/partner support.

Table 17. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Psychological Health

Pairwise Comparisons

Dependent Variable: Psy

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
no problem	slight problem	-2.594*	.618	.000	-4.232	-.955
	moderate problem	-7.138*	.937	.000	-9.621	-4.656
	major problem	-8.744*	1.084	.000	-11.616	-5.872
slight problem	no problem	2.594*	.618	.000	.955	4.232
	moderate problem	-4.545*	1.023	.000	-7.255	-1.835
	major problem	-6.150*	1.158	.000	-9.218	-3.082
moderate problem	no problem	7.138*	.937	.000	4.656	9.621
	slight problem	4.545*	1.023	.000	1.835	7.255
	major problem	-1.606	1.355	1.000	-5.197	1.985
major problem	no problem	8.744*	1.084	.000	5.872	11.616
	slight problem	6.150*	1.158	.000	3.082	9.218
	moderate problem	1.606	1.355	1.000	-1.985	5.197

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

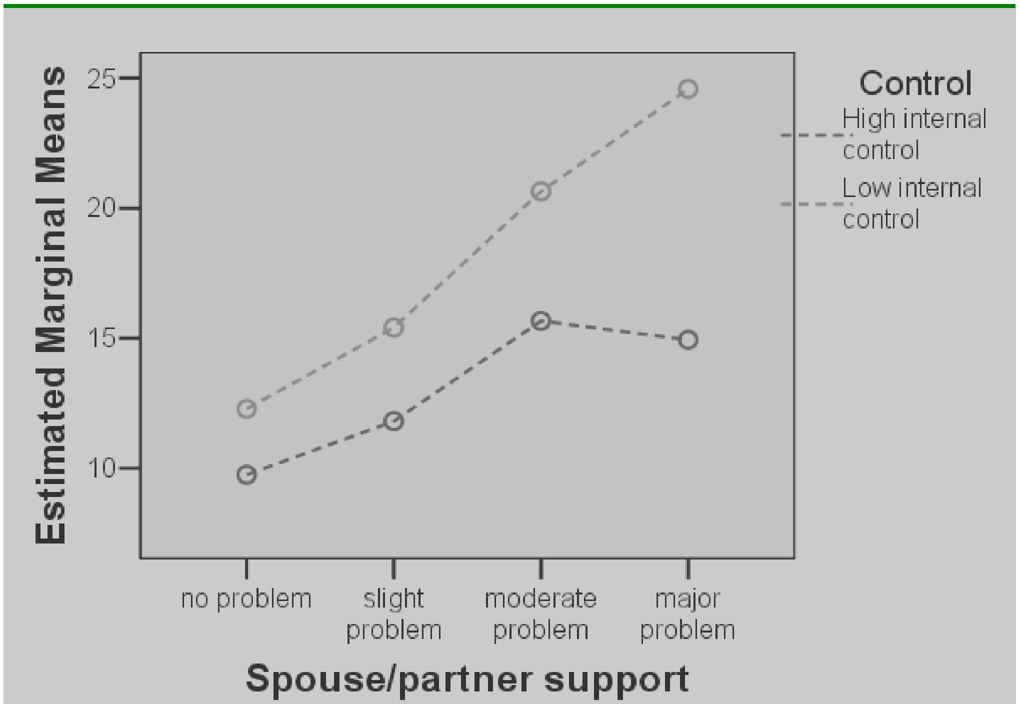


Figure 10. Interaction of Spouse/Partner Social Support and Shiftwork Locus of Control on Psychological Health.

More specifically, although descriptive statistics as predicted confirmed that for each of the four levels of spouse/partner support, employees in the high internal shiftwork locus of control group scored better on a measure of psychological health (GHQ) than those in the corresponding low internal group, the buffering effect of high internal control was especially pronounced when spouse/partner support was perceived to be a major problem (M = 15.11, SD = 4.54) as compared to the low internal control group (M = 25.04, SD = 8.93), with an average difference between the subgroups of approximately 1.09 SD. Thus for spouse/partner relationships that were reported as significantly problematic in terms of employee-perceived support, lower internal shiftwork locus of control yielded significantly poorer psychological health scores.

Moreover, better levels of spouse/partner support successively facilitated better adjustment in the context of low internal shiftwork locus of control. In the high internal control group, better levels of spouse/partner support also facilitated successively better adjustment for the no problem, slight problem, and moderate problem support subgroups. Specifically, employees reporting no spouse/partner support problems within the high internal control group (M = 9.37, SD = 4.12) had an average adjustment score of .33 SD better than those reporting a slight problem, (M = 11.65, SD = 3.53), .91 SD better than those reporting a moderate problem (M = 15.67, SD = 9.53), and .83 SD better than those indicating a major problem ($M = 15.11$, $SD = 4.54$), with those employees reporting better spouse/partner support and indicating high internal shiftwork locus of control having the greatest overall psychological health.

Similar to the interaction effect between support and control on adjustment, as support problems progress from moderate to major, the buffering effect of high internal control on psychological health is further enhanced yielding significantly increased divergence between high and low control effects as depicted in Figure 10. This further underscores the combined value of both greater levels of spouse/partner support and higher internal levels of shiftwork locus of control in predicting adjustment outcomes, including psychological health.

Physical Adjustment

ANCOVAs were conducted and showed a significant main effect for shiftwork locus of control on physical adjustment at follow-up ($F(1, 367) = 23.53$, $p < .001$), after controlling for the effect of physical adjustment at baseline ($F(1, 367) = 91.13$, $p < .001$). More specifically, physical adjustment was significantly better in the high internal control group ($M = -.67$, $SD = 1.17$) as compared to the low internal control group ($M = .54$, $SD = 1.98$), with approximately .72 SD separating their average scores, suggesting that employees with higher levels of internal shiftwork locus of control experienced better overall physical adjustment.

Similarly, a significant main effect was found for support on physical adjustment ($F(3, 367) = 16.78$, $p < .001$) after controlling for the effect of physical adjustment at baseline as noted above. Specifically, those employees with no reported problems concerning perceived spouse/partner support tended to have better physical adjustment ($M = -.62$, $SD = 1.17$) than those employees reporting spouse/partner support levels as a slight problem ($M = .21$, $SD = 1.65$), a moderate problem ($M = 1.24$, $SD = 1.96$), or a major problem ($M = 2.00$, $SD = 2.83$), with physical adjustment becoming progressively worse overall as reported support diminished.

Moreover, Bonferroni adjusted pairwise comparisons of support levels on physical adjustment based on estimated marginal means (see Table 18) showed significant differences in the predicted directions for four of the six possible pairings, including no problem/slight problem ($p = .01$), no problem/moderate problem ($p < .001$), no problem/major problem ($p < .001$), and slight problem/major problem ($p < .01$), with no significant differences found for the two pairings of slight problem/moderate problem and moderate problem/major problem.

ANCOVAs also found a significant interaction between support and control on physical adjustment ($F(3, 367) = 2.96$, $p < .05$). The interaction is displayed graphically using model-predicted estimated marginal mean plots (see Figure 11, page 256). As with control and support's interaction effect on adjustment as well as on psychological health, the buffering effect of high internal shiftwork locus of control on physical adjustment was significantly influenced by the degree of spouse/partner support.

Table 18. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Physical Adjustment

Pairwise Comparisons

Dependent Variable: Phys

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
no problem	slight problem	-.591*	.169	.003	-1.040	-.141
	moderate problem	-1.196*	.256	.000	-1.875	-.516
	major problem	-1.671*	.306	.000	-2.483	-.860
slight problem	no problem	.591*	.169	.003	.141	1.040
	moderate problem	-.605	.280	.189	-1.348	.138
	major problem	-1.080*	.327	.006	-1.947	-.213
moderate problem	no problem	1.196*	.256	.000	.516	1.875
	slight problem	.605	.280	.189	-.138	1.348
	major problem	-.475	.374	1.000	-1.469	.518
major problem	no problem	1.671*	.306	.000	.860	2.483
	slight problem	1.080*	.327	.006	.213	1.947
	moderate problem	.475	.374	1.000	-.518	1.469

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

More specifically, although descriptive statistics as predicted confirmed that for each of the four levels of spouse/partner support, employees in the high internal shiftwork locus of control group scored better on a measure of physical adjustment than those in the corresponding low internal group, the buffering effect of high internal control was especially pronounced when spouse/partner support was perceived to be a major problem (M = .29, SD = 1.04) as compared to the low internal control group (M = 2.75, SD = 3.06), with an average difference between the subgroups of approximately .87 SD. Thus for spouse/partner relationships

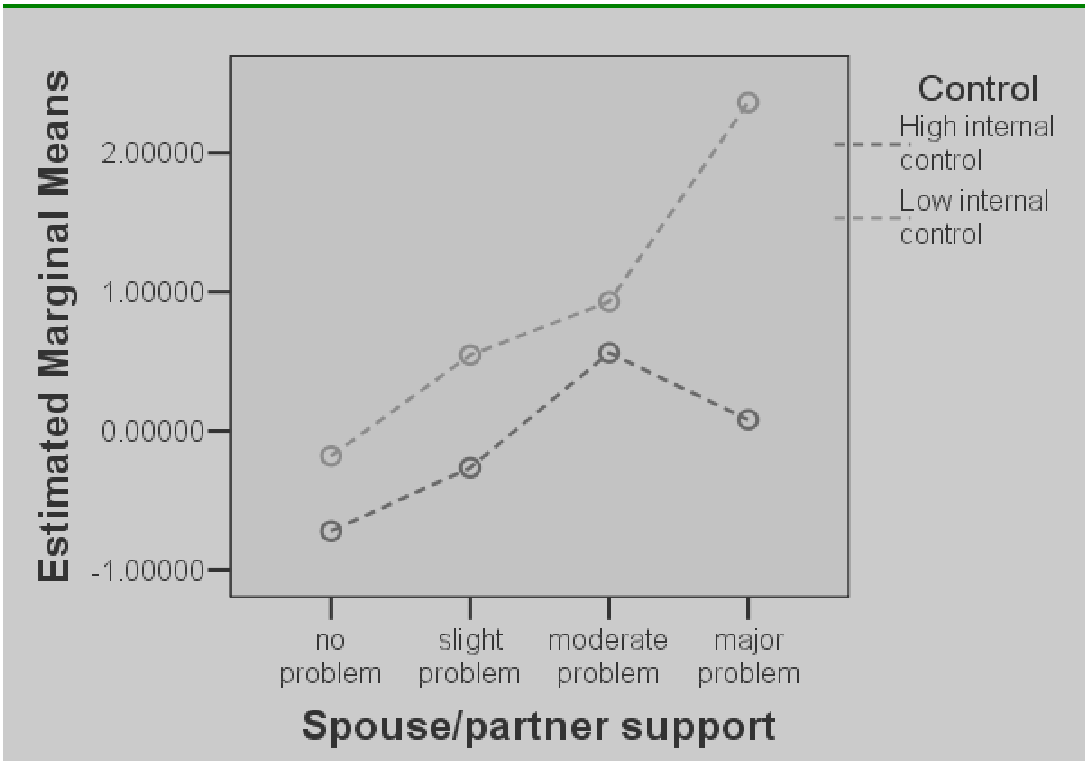


Figure 11. Interaction of Spouse/Partner Social Support and Shiftwork Locus of Control on Physical Adjustment.

that were reported as significantly problematic in terms of employee-perceived support, lower internal shiftwork locus of control yielded significantly poorer employee physical adjustment as tapped by a composite measure of physical health (PHQ) and medical diagnoses (Med).

Moreover, employees reporting no spouse/partner support problems within the high internal control group (M = -.89, SD = .98) had an average adjustment score of .39 SD better than those reporting a slight problem, (M = -.43, SD = 1.20), .1.62 SD better than those reporting a moderate problem ($M = 1.00$, $SD = 1.80$), and only 1.01 SD better than those indicating a major problem ($M = .29$, $SD = 1.04$), with those employees reporting better spouse/partner support and indicating high internal shiftwork locus of control showing the best overall physical adjustment.

Similar to the interaction effect between support and control on overall adjustment as well as on psychological adjustment previously described, as support problems progress from moderate to major, the buffering effect of high internal control on physical health is further enhanced yielding increased divergence between high and low control effects as depicted in Figure 11. This further highlights the combined value of both greater levels of spouse/partner support and higher internal levels of shiftwork locus of control in predicting physical adjustment, as well as overall adjustment and psychological health as previously noted.

Physical Health

To add additional texture to the present study's findings concerning the roles of control and support in predicting physical adjustment, the component indice of physical health (PHQ) was also tested as an outcome measure. ANCOVAs were conducted and showed a significant main effect for shiftwork locus of control on physical health at follow-up ($F(1, 413) = 28.15$, $p < .001$), after controlling for the effect of physical health at baseline ($F(1, 413) = 137.48$, $p < .001$). More specifically, physical health was significantly better in the high internal control group ($M = 9.13$, $SD = 8.12$) as compared to the low internal control group ($M = 17.22$, $SD = 11.63$), with approximately .76 SD separating their average scores, suggesting that employees with higher levels of internal shiftwork locus of control were in better physical health.

Similarly, a significant main effect was found for support on physical health ($F (3, 413) = 15.92$, $p < .001$) after controlling for the effect of physical health at baseline as previously noted. Specifically, those employees with no reported problems concerning perceived spouse/partner support tended to have better physical health at follow-up ($M = 9.68$, $SD = 8.54$), than those employees reporting spouse/partner support levels as a slight problem ($M = 15.14$, $SD = 9.79$), a moderate problem ($M = 18.77$, $SD = 10.12$), or a major problem ($M = 27.11$, $SD = 15.31$), with employees being in progressively poorer health overall as reported support diminished.

Moreover, Bonferroni adjusted pairwise comparisons of support levels on physical health based on estimated marginal means (see Table 19) showed significant differences in the predicted directions for four of the six possible pairings, including no problem/slight problem ($p = .001$), no problem/moderate problem ($p < .01$), no problem/major problem ($p < .001$), and slight problem/major problem ($p < .01$), with no significant differences found for the two pairings of slight problem/moderate problem and moderate problem/major problem.

ANCOVAs also found a significant interaction between support and control on physical health ($F (3, 413) = 3.12$, $p < .05$). The interaction is

Table 19. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Physical Health (PHQ)

Pairwise Comparisons

Dependent Variable: CvD

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
no problem	slight problem	-3.735*	.973	.001	-6.314	-1.155
	moderate problem	-5.196*	1.413	.002	-8.942	-1.450
	major problem	-10.310*	1.814	.000	-15.118	-5.503
slight problem	no problem	3.735*	.973	.001	1.155	6.314
	moderate problem	-1.462	1.553	1.000	-5.579	2.656
	major problem	-6.576*	1.923	.004	-11.675	-1.477
moderate problem	no problem	5.196*	1.413	.002	1.450	8.942
	slight problem	1.462	1.553	1.000	-2.656	5.579
	major problem	-5.114	2.162	.111	-10.846	.617
major problem	no problem	10.310*	1.814	.000	5.503	15.118
	slight problem	6.576*	1.923	.004	1.477	11.675
	moderate problem	5.114	2.162	.111	-.617	10.846

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

displayed graphically using model-predicted estimated marginal mean plots (see Figure 12, page 260). As with control and support's interaction effect on adjustment as well as on psychological health and physical adjustment, the buffering effect of high internal shiftwork locus of control on physical health was significantly influenced by the degree of spouse/partner support.

More specifically, although descriptive statistics as predicted confirmed that for each of the four levels of spouse/partner support, employees in the high internal shiftwork locus of control group scored better on a measure of physical health than those in the corresponding low internal group, the buffering effect of high internal control was especially pronounced when spouse/partner support was considered to be a major

Figure 12. Interaction of Spouse/Partner Social Support and Shiftwork Locus of Control on Physical Health (PHQ).

problem (M = 16.43, SD = 6.40) as compared to the low internal control group (M = 30.85, SD = 15.85), with an average difference between the subgroups of approximately .94 SD. Thus for spouse/partner relationships that were reported as significantly problematic in terms of employee-perceived support, lower internal shiftwork locus of control yielded significantly poorer employee physical health as assessed via significantly increased cardiovascular and digestive symptomatoloty, whereas higher levels of internal control buffered against such cardiovascular and digestive concerns.

Moreover, employees reporting no spouse/partner support problems within the high internal control group (M = 7.73, SD = 7.49) had an average adjustment score of .43 SD better than those reporting a slight problem, (M = 11.24, SD = 7.85), .61 SD better than those reporting a moderate problem (M = 16.23, SD = 10.80), and only .64 SD better than those indicating a major problem (M = 16.43, SD = 6.40), with those employees reporting better spouse/partner support and indicating high internal shiftwork locus of control having the best overall physical health in terms of fewer cardiovascular and digestive symptomatology

Similar to the interaction effect between support and control on overall adjustment as well as on psychological and overall physical adjustment previously described, as support problems progress from moderate to major, the buffering effect of high internal control on physical health is further enhanced yielding increased divergence between high and low control effects as depicted in Figure 11. This further highlights the combined value of both improved levels of spouse/partner support and higher internal levels of shiftwork locus of control in predicting physical health, as well as overall physical adjustment, psychological health, and overall adjustment as previously noted.

Medical Diagnoses

To add further texture to the present study's findings concerning the roles of control and support in predicting physical adjustment, the additional component indice of medical diagnoses since starting shiftwork

(Med) was utilized as an outcome measure. ANCOVAs were conducted and showed a significant main effect for shiftwork locus of control on medical diagnoses at follow-up ($F (1, 431) = 12.55$, $p < .001$), after controlling for medical diagnoses at baseline ($F (1, 431) = 49.98$, $p < .001$). More specifically, employee-reported medical diagnoses since starting shiftwork were significantly less in the high internal control group ($M = 1.28$, $SD = 2.24$) as compared to the low internal control group ($M = 2.79$, $SD = 3.62$), with approximately .49 SD separating their average scores, suggesting that employees with higher levels of internal shiftwork locus of control had fewer medically diagnosed conditions emerge since working shifts.

Similarly, a significant main effect was found for support on medical diagnoses ($F (3, 431) = 14.13$, $p < .001$). Specifically, those employees with no reported problems concerning perceived spouse/partner support tended to have fewer medical diagnoses ($M = 1.20$, $SD = 1.90$) than those employees reporting spouse/partner support levels as a slight problem ($M = 2.30$, $SD = 3.52$), a moderate problem ($M = 4.07$, $SD = 3.90$), or a major problem ($M = 5.00$, $SD = 4.84$), with medical diagnoses becoming progressively more frequent as support diminished.

Moreover, Bonferroni adjusted pairwise comparisons of support levels on medical diagnoses at follow-up based on estimated marginal means (see Table 20) showed significant differences in the predicted directions for three of the six possible pairings, including no problem/slight problem ($p < .05$), no problem/moderate problem ($p < .001$), no problem/major problem ($p < .001$), and slight problem/major problem ($p < .01$), with no significant differences found for the slight problem/moderate problem and moderate problem/major problem pairings.

Table 20. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Medical Diagnoses

Pairwise Comparisons

Dependent Variable: Med

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
no problem	slight problem	-.853*	.319	.046	-1.698	-.009
	moderate problem	-2.078*	.471	.000	-3.327	-.828
	major problem	-2.824*	.552	.000	-4.287	-1.362
slight problem	no problem	.853*	.319	.046	.009	1.698
	moderate problem	-1.224	.517	.110	-2.595	.146
	major problem	-1.971*	.592	.006	-3.540	-.403
moderate problem	no problem	2.078*	.471	.000	.828	3.327
	slight problem	1.224	.517	.110	-.146	2.595
	major problem	-.747	.682	1.000	-2.553	1.060
major problem	no problem	2.824*	.552	.000	1.362	4.287
	slight problem	1.971*	.592	.006	.403	3.540
	moderate problem	.747	.682	1.000	-1.060	2.553

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

ANCOVAs did not find a significant interaction between support and control on medical diagnoses at follow-up ($F(3, 431) = 1.51$, $p = .21$), although the power to detect an interaction was somewhat low at .40. The relationship between control and support in predicting medical diagnoses is displayed graphically using model-predicted estimated marginal mean plots (see Figure 13, page 264). As with control and support's significant interaction on overall adjustment as well as on psychological health, overall physical adjustment, and physical health as previously described, the buffering influence of high internal shiftwork locus of control on medical diagnoses at follow-up showed increased divergence between high and low control effects for those employees that reported major spouse/partner support problems.

Figure 13. Interaction of Spouse/Partner Social Support and Shiftwork Locus of Control on Medical Diagnoses.

Operational Performance

Additional ANCOVAs were also conducted and showed a significant main effect for shiftwork locus of control on operational performance (Perf) at follow-up (F (1, 477) = 47.11, p < .001), after controlling for the effect of operational performance at baseline ($F\ (1, 477) = 58.75$, $p < .001$). More specifically, performance was significantly better in the high internal control group ($M = -.74$, $SD = 1.39$) as compared to the low internal control group ($M = .84$, $SD = 1.80$), with approximately .89 SD separating their average scores, suggesting that employees with higher levels of internal shiftwork locus of control delivered better operational performance as tapped via the present study's composite index of productivity and safety (see Table 7: Variable Labels, Names, and Descriptions, page 185 for scale construction metrics).

Similarly, a significant main effect was found for support on operational performance ($F\ (3, 477) = 24.79$, $p < .001$) after controlling for the effect of operational performance at baseline as noted above. Specifically, those employees with no reported problems concerning perceived spouse/partner support tended to contribute better performance ($M = -.59$, $SD = 1.53$) than those employees reporting spouse/partner support levels as a slight problem ($M = .37$, $SD = 1.59$), a moderate problem ($M = 1.10$, $SD = 1.61$), or a major problem ($M = 2.26$, $SD = 1.76$), with performance becoming progressively worse overall as reported support diminished.

Moreover, Bonferroni adjusted pairwise comparisons of support levels on operational performance based on estimated marginal means (see Table 21) showed significant differences in the predicted directions for four of the six possible pairings, including no problem/slight problem (p

< .001), no problem/moderate problem (p < .001), no problem/major problem (p < .001), and slight problem/major problem (p < .001), with no significant differences found for the two pairings of slight problem/moderate problem and moderate problem/major problem.

Table 21. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Operational Performance

Pairwise Comparisons

Dependent Variable: Perf

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
no problem	slight problem	-.678*	.159	.000	-1.098	-.258
	moderate problem	-1.139*	.225	.000	-1.735	-.543
	major problem	-1.997*	.282	.000	-2.745	-1.250
slight problem	no problem	.678*	.159	.000	.258	1.098
	moderate problem	-.461	.249	.387	-1.120	.198
	major problem	-1.319*	.300	.000	-2.115	-.524
moderate problem	no problem	1.139*	.225	.000	.543	1.735
	slight problem	.461	.249	.387	-.198	1.120
	major problem	-.858	.340	.072	-1.760	.043
major problem	no problem	1.997*	.282	.000	1.250	2.745
	slight problem	1.319*	.300	.000	.524	2.115
	moderate problem	.858	.340	.072	-.043	1.760

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

ANCOVAs did not find a significant interaction between support and control on operational performance (F (3, 367) = 1.39, p = .24), although the power to detect an interaction was fairly low at .37. Interestingly, the relationship between support and control in predicting performance is somewhat similar to that found among the significant interactions between support and control on overall adjustment, psychological health, overall physical adjustment and physical health previously described in that – as displayed graphically using model-predicted estimated marginal mean plots (see Figure 14 page 267) – the effects of high versus low control on operational performance diverge most among those employees reporting major spouse/partner support problems.

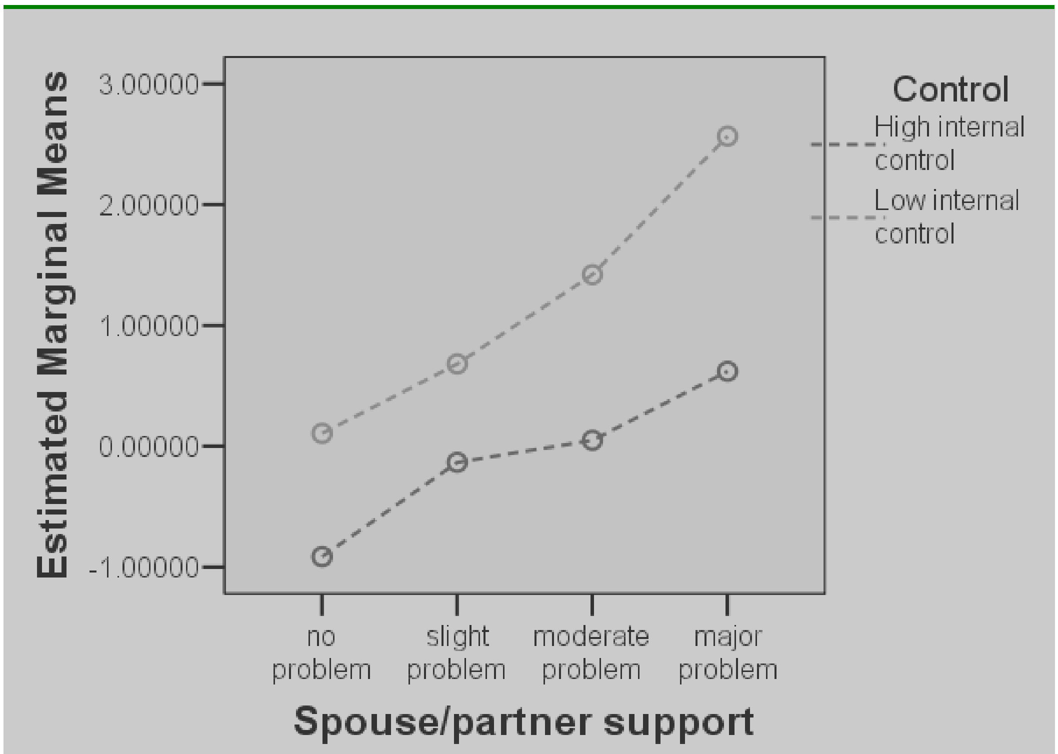


Figure 14. Relationship between Spouse/Partner Social Support and Shiftwork Locus of Control in Predicting Operational Performance.

Safety

To assess changes in safety at follow-up, the component indice of safety (Safe) was utilized as an outcome measure. ANCOVAs were conducted and showed a significant main effect for shiftwork locus of control on safety at follow-up ($F(1, 484) = 24.68$, $p < .001$), after controlling for the effect of safety at baseline ($F(1, 484) = 79.18$, $p < .001$). More specifically, safety risk was significantly better managed in the high internal control group ($M = 6.03$, $SD = .2.63$) as compared to the low internal control group ($M = 8.17$, $SD = 3.59$), with approximately .65 SD separating the average scores, suggesting that those with higher levels of internal shiftwork locus of control better managed safety risk at follow-up.

Similarly, a significant main effect was found for support on safety ($F(3, 484) = 13.84$, $p < .001$), after controlling for the effects of safety at baseline as noted. Specifically, those employees with no reported problems concerning perceived spouse/partner support tended to be better prepared to manage safety at follow-up ($M = 6.15$, $SD = 2.73$) than those reporting spouse/partner support levels as a slight problem ($M = 7.55$, $SD = 3.11$), a moderate problem ($M = 8.53$, $SD = 3.79$), or a major problem ($M = 10.74$, $SD = 3.82$), with safety practices becoming progressively worse overall as employee-reported spouse/partner support diminished.

Moreover, Bonferroni adjusted pairwise comparisons of support levels on safety at follow-up based on estimated marginal means (see Table 22) showed significant differences in the predicted directions for four of the six possible pairings, including no problem/slight problem ($p < .05$), no problem/moderate problem ($p < .01$), no problem/major problem ($p < .001$), and slight problem/major problem, $p < .01$, with no significant

Table 22. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Safety

Pairwise Comparisons

Dependent Variable: Safe

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
no problem	slight problem	-.937*	.313	.017	-1.765	-.109
	moderate problem	-1.568*	.444	.003	-2.743	-.393
	major problem	-3.063*	.557	.000	-4.539	-1.587
slight problem	no problem	.937*	.313	.017	.109	1.765
	moderate problem	-.631	.490	1.000	-1.931	.668
	major problem	-2.126*	.593	.002	-3.697	-.555
moderate problem	no problem	1.568*	.444	.003	.393	2.743
	slight problem	.631	.490	1.000	-.668	1.931
	major problem	-1.494	.673	.161	-3.276	.287
major problem	no problem	3.063*	.557	.000	1.587	4.539
	slight problem	2.126*	.593	.002	.555	3.697
	moderate problem	1.494	.673	.161	-.287	3.276

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

differences found for the pairings of slight problem/moderate problem and moderate problem/major problem.

ANCOVAs did not yield a significant interaction effect between support and control on safety at follow-up (F (3, 484) = 2.16, p = .09), although the power to detect an interaction was only .55. The relationship between control and support in predicting safety is displayed graphically using model-predicted estimated marginal mean plots (see Figure 15, page 270). As with control and support's significant interaction effect on adjustment as well as on psychological health, overall physical adjustment, and physical health, the buffering effect of high internal shiftwork locus of control on safety at follow-up showed increased divergence from the low internal control group when employees reported major problems with spouse/partner support.

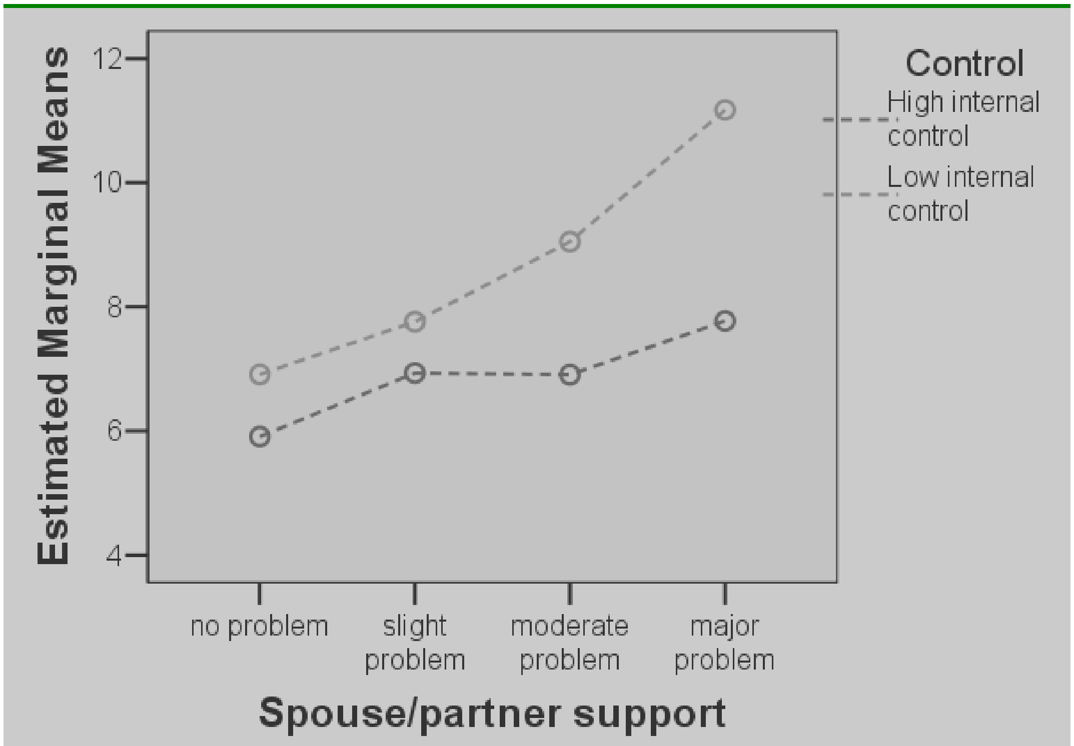


Figure 15. Interaction of Spouse/Partner Social Support and Shiftwork Locus of Control on Safety.

Productivity

To explore productivity as a component indice of operational performance, additional ANCOVAs were conducted and showed a significant main effect for shiftwork locus of control on productivity (Prod) at follow-up ($F(1, 485) = 43.60$, $p < .001$), after controlling for the effect of productivity at baseline ($F(1, 485) = 31.94$, $p < .001$). More specifically, performance was significantly better in the high internal control group (M = 10.00, SD = 2.91) as compared to the low internal control group (M = 13.26, SD = 3.29), with approximately .93 SD separating their average scores, suggesting that employees with higher levels of internal shiftwork locus of control delivered were more productive.

Similarly, a significant main effect was found for support on productivity ($F(3, 485) = 22.68$, $p < .001$) after controlling for the effect of productivity at baseline as noted above. Specifically, those employees with no reported problems concerning perceived spouse/partner support tended to contribute better performance (M = 10.43, SD = 3.17) than those employees reporting spouse/partner support levels as a slight problem (M = 12.29, SD = 3.10), a moderate problem (M = 13.64, SD = 2.99), or a major problem (M = 15.60, SD = 2.97), with productivity becoming progressively poorer overall as support diminished.

Moreover, Bonferroni adjusted pairwise comparisons of support levels on productivity based on estimated marginal means (see Table 23) showed significant differences in the predicted directions for four of the six possible pairings, including no problem/slight problem ($p < .001$), no problem/moderate problem ($p < .001$), no problem/major problem ($p < .001$), and slight problem/major problem ($p = .001$), with no significant differences found for the two pairings of slight problem/moderate problem and moderate problem/major problem.

Table 23. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Productivity

Pairwise Comparisons

Dependent Variable: prod

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
no problem	slight problem	-1.375*	.316	.000	-2.214	-.537
	moderate problem	-2.198*	.451	.000	-3.393	-1.003
	major problem	-3.749*	.565	.000	-5.247	-2.251
slight problem	no problem	1.375*	.316	.000	.537	2.214
	moderate problem	-.823	.498	.594	-2.142	.496
	major problem	-2.374*	.602	.001	-3.969	-.778
moderate problem	no problem	2.198*	.451	.000	1.003	3.393
	slight problem	.823	.498	.594	-.496	2.142
	major problem	-1.551	.682	.140	-3.358	.256
major problem	no problem	3.749*	.565	.000	2.251	5.247
	slight problem	2.374*	.602	.001	.778	3.969
	moderate problem	1.551	.682	.140	-.256	3.358

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

ANCOVAs did not find a significant interaction between support and control on productivity (F (3, 485) = .49, p = .69), although the power to detect an interaction was low at .15. Interestingly, the relationship between support and control in predicting productivity is somewhat similar to that found among the significant interactions between support and control on overall adjustment, psychological health, overall physical adjustment and physical health previously described in that – as displayed graphically using model-predicted estimated marginal mean plots (see Figure 16, page 273) – the effects of high versus low control on productivity diverge most among those employees reporting major spouse/partner support problems.

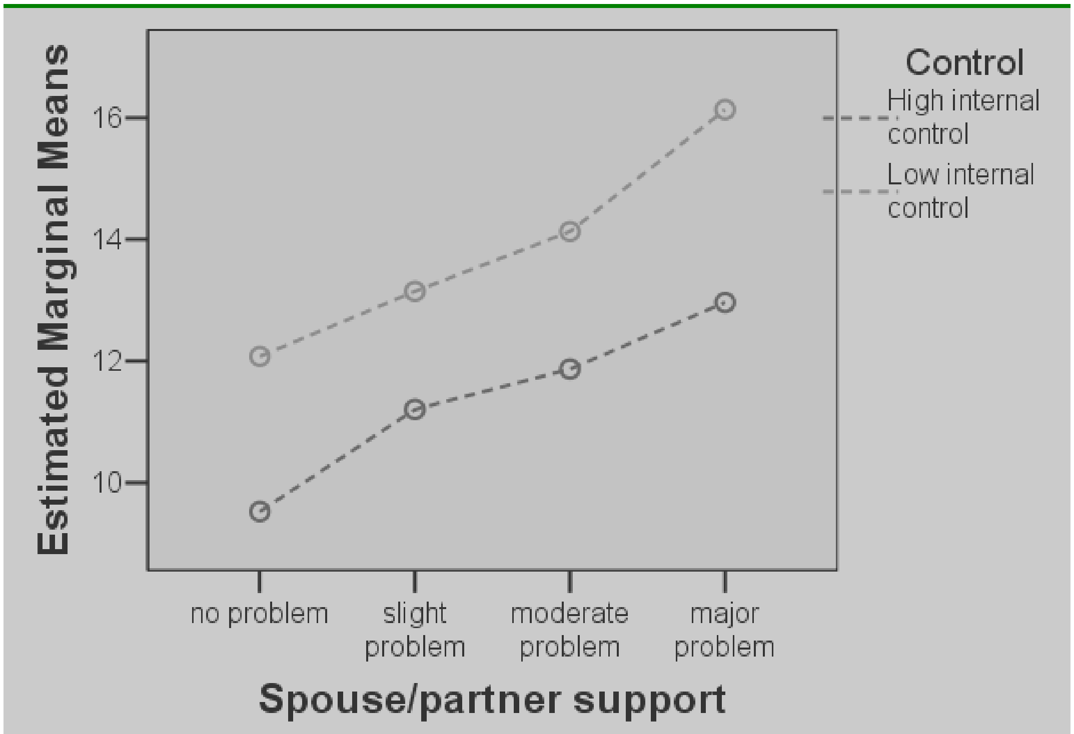


Figure 16. Relationship between Spouse/Partner Social Support and Shiftwork Locus of Control in Predicting Productivity.

Comparative Productivity at Follow-Up

To add additional texture to the present study's findings concerning the roles of control and support in predicting productivity as a component of operational performance, an additional measure of comparative productivity at follow-up (Proc) was utilized as an outcome measure (see page 164). ANOVAs were conducted and showed a significant main effect for shiftwork locus of control on comparative productivity at follow-up ($F(1, 493) = 33.79$, $p < .001$). More specifically, employee-perceived comparative productivity was significantly better in the high internal control group ($M = 2.80$, $SD = .74$) as compared to the low internal control group ($M = 3.35$, $SD = .84$), with approximately .66 SD separating their average scores, suggesting that employees with higher levels of internal shiftwork locus of control delivered increased productivity at follow-up.

Similarly, a significant main effect was found for support on comparative productivity ($F(3, 493) = 12.85$, $p < .001$). Specifically, those employees with no reported problems concerning perceived spouse/partner support tended to have better productivity at follow-up ($M = 2.83$, $SD = .73$) than those employees reporting spouse/partner support levels as a slight problem ($M = 3.25$, $SD = .75$), a moderate problem ($M = 3.50$, $SD = .95$), or a major problem ($M = 3.77$, $SD = 1.00$), with employee-perceived productivity becoming progressively worse overall as support diminished.

Moreover, Bonferroni adjusted pairwise comparisons of support levels on comparative productivity at follow-up based on estimated marginal means (see Table 24) showed significant differences in the predicted directions for three of the six possible pairings, including no problem/slight problem ($p < .001$), no problem/moderate problem ($p < .01$), and no problem/major problem ($p < .001$), with no significant differences found for the three pairings of slight problem/moderate problem, slight problem/major problem, and moderate problem/major problem.

Table 24. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Comparative Productivity at Follow-Up

Pairwise Comparisons

Dependent Variable: proc

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
no problem	slight problem	-.360*	.085	.000	-.584	-.135
	moderate problem	-.421*	.122	.004	-.743	-.099
	major problem	-.677*	.152	.000	-1.079	-.275
slight problem	no problem	.360*	.085	.000	.135	.584
	moderate problem	-.061	.134	1.000	-.417	.294
	major problem	-.318	.162	.304	-.747	.112
moderate problem	no problem	.421*	.122	.004	.099	.743
	slight problem	.061	.134	1.000	-.294	.417
	major problem	-.256	.184	.986	-.744	.231
major problem	no problem	.677*	.152	.000	.275	1.079
	slight problem	.318	.162	.304	-.112	.747
	moderate problem	.256	.184	.986	-.231	.744

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

Subsequent to the two X four ANOVA exploring contributions of control and support on comparative productivity, Scheffe post hoc tests were also conducted to further assess group differences for the four-level spouse/partner support factor (see Table 25). Results are somewhat less conservative as compared to Bonferroni adjusted pairwise comparisons of support on comparative productivity (table 22); however, the only statistically meaningful difference between the pairwise comparison tests is the finding using Scheffe post hoc tests of a significant difference for the slight problem/major problem pairing.

Table 25. Scheffe Post Hoc Tests to Assess Group Differences in Spouse/Partner Support on Productivity at Follow-Up

Multiple Comparisons

Dependent Variable: proc
Scheffe

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
no problem	slight problem	-.41*	.084	.000	-.65	-.18
	moderate problem	-.67*	.109	.000	-.97	-.36
	major problem	-.94*	.134	.000	-1.31	-.56
slight problem	no problem	.41*	.084	.000	.18	.65
	moderate problem	-.25	.123	.244	-.60	.09
	major problem	-.52*	.146	.005	-.93	-.11
moderate problem	no problem	.67*	.109	.000	.36	.97
	slight problem	.25	.123	.244	-.09	.60
	major problem	-.27	.162	.422	-.73	.18
major problem	no problem	.94*	.134	.000	.56	1.31
	slight problem	.52*	.146	.005	.11	.93
	moderate problem	.27	.162	.422	-.18	.73

Based on observed means.

*. The mean difference is significant at the .05 level.

ANCOVAs also found a significant interaction between support and control on comparative productivity at follow-up (F (3, 493) = 2.82, p < .05). The interaction is displayed graphically using model-predicted estimated marginal mean plots (see Figure 17, page 277). As with control and support's interaction effect on adjustment as well as on psychological health, overall physical adjustment, and physical health, the buffering effect of high internal shiftwork locus of control on comparative productivity at follow-up was influenced by the degree of spouse/partner support.

Figure 17. Interaction of Spouse/Partner Social Support and Shiftwork Locus of Control on Comparative Productivity at Follow-up.

More specifically, although descriptive statistics as predicted confirmed that for each of the four levels of spouse/partner support, employees in the high internal shiftwork locus of control group delivered greater levels of employee-perceived comparative productivity at follow-upon than those in the corresponding low internal group, the buffering effect of high internal control was especially pronounced when spouse/partner support was perceived to be either a moderate (M = 2.87, SD = .83) or a major problem (M = 3.11, SD = .78) as compared to the low internal control group (M = 3.73, SD = .90; M = 4.00, SD = .98) for moderate and major problems, respectively, with an average difference between the subgroups of approximately .90 SD and .89 SD for moderate and major problems, respectively. Thus for spouse/partner relationships that were reported as either moderate or major problems according to employee-perceived support, lower internal shiftwork locus of control yielded significantly poorer employee-perceived productivity.

Moreover, employees reporting no spouse/partner support problems within the high internal control group (M = 2.70, SD = .72) had an average adjustment score of .57 SD better than those reporting a slight problem, (M = 3.12, SD = .69), a drop to only .23 SD better than those reporting a moderate problem (M = 2.87, SD = .83), and only .55 SD better than those indicating a major problem (M = 3.11, SD = .78), with those employees reporting better spouse/partner support and indicating high internal shiftwork locus of control being the most productive at follow-up.

Interestingly, whereas low internal control shows a near perfect linear positive relationship with comparative productivity across spouse/partner support levels, with employee-perceived productivity successively decreasing progressing from no problem to major problem (see Figure 13; note, higher productivity scores represent poorer performance), the relative buffering effect of high internal control in protecting comparative productivity was further enhanced in the context of moderate and major employee-perceived spouse/partner support problems, yielding significantly increased divergence between high and low control effects as depicted in Figure 13. This provides further evidence of the combined benefits of both improved levels of spouse/partner support and higher internal levels of shiftwork locus of control in predicting productivity, as well as in predicting psychological health, overall physical adjustment, physical health, and overall adjustment as previously described.

Summary of Results Relating to Hypothesis 8

Results relating to the unique and combined effects of control and support on composite adjustment and its component indices showed significant main effects for both shiftwork locus of control and spouse/partner support on all adjustment indices in the present study including: composite adjustment (Adj), psychological adjustment (GHQ), physical adjustment (Phys), physical health (PHQ), medical diagnoses (Med), operational performance (Perf), safety (Safe), and productivity (Prod), as well as an additional measure of comparative productivity at follow-up (Proc).

Interaction effects were also found for shiftwork locus of control and spouse/partner support on composite adjustment (Adj), psychological health (GHQ), physical adjustment (Phys), physical health (PHQ), and comparative productivity (Proc). No Interaction effects were found for shiftwork locus of control and spouse/partner support on the component adjustment indices of medical diagnoses (Med), operational performance (Perf), safety (Safe), or productivity (Prod).

Interestingly, for the five significant and four non-significant interactions noted above, all nine adjustment indices showed the greatest divergence of results between high versus low internal control for those employees reporting major spouse/partner support problems, where the buffering effects of high internal shiftwork locus of control yielded the greatest difference in adjustment. Across all indices, the best levels of adjustment were achieved by those employees in the no spouse/partner support problems/high internal shiftwork locus of control subgroup.

As well, across all support levels, high internal control predicted better adjustment than low internal control. Moreover, average adjustment outcomes (e.g., including both high and low internal control subgroups) across all adjustment indices were progressively better at each successive level of improved employee-reported spouse/partner support; that is, the no support problem group evidenced better adjustment than the slight problem group, who in turn did better than those reporting moderate issues, who did better yet than those indicating major spouse/partner support problems.

Predicting Adjustment through Coping: Control and Support Effects Relating to Hypothesis 9

To explore coping's mediating role in predicting control and support effects on adjustment in the present study (see Hypothesis 9, page 136) Baron and Kenny's (1986) four criteria of mediation were tested (see Figure 6, page 239), including criteria D – that the impact of control and support on adjustment after controlling for coping was less than a significant association between control and support on adjustment without controlling for coping – by comparing differences in adjustment at follow-up predicted by control and support after controlling for coping and also corresponding measures of adjustment at baseline, and then comparing these effects to differences in adjustment predicted by control and support without controlling for coping.

ANCOVAs were conducted with control and support input as independent variables. Shiftwork locus of control was parsed into high and low internal control defined by median split (see page 206) and spouse/partner support was parsed into four levels according to perceived level of support. Coping measures were input as covariates, and adjustment at follow-up was entered as the dependent variable with corresponding adjustment at baseline entered as an additional covariate. Comparison ANCOVAs were then performed to test for mediating effects by removing coping as a covariate.

Auxiliary Coping as Mediator

Applying Baron and Kenny's (1986) four conditions of mediation as described previously and depicted in Figure 6 (see page 239), Figure 18 portrays these four requirements of mediation with respect to shiftwork locus of control and spouse/partner support effects on adjustment. Requirements B and C were previously tested (see Summary of Results Relating to Hypothesis 8, page 279 and Hypotheses 4, page 236, respectively). Utilizing the present study's measure of composite adjustment as the dependent variable of interest, results from tests B and C identified auxiliary coping (but not adaptive coping or approach coping) as a potential mediator between shiftwork locus of control and adjustment, between spouse/partner support and adjustment, and between the interaction of shiftwork locus of control and spouse/partner support on adjustment.

A.	Ctrl, Supp	⟶	Coping
B.	Ctrl, Supp	⟶	Adjustment
C.	Coping	⟶	Adjustment
D.	(Ctrl, Supp	impact	Adjustment, Controlling for Coping) < B

Figure 18. Four Conditions Required for Coping to Demonstrate Mediation in the Present Study with Respect to Control and/or Support (Adapted from Baron & Kenny, 1986). Note, "⟶" indicates a significant association.

To test condition A —that the predictor (i.e.., control, support, or their interaction) is significantly associated with the hypothesized mediator (i.e., auxiliary coping), ANCOVAs were conducted with control and support input as fixed factors. Control was parsed into two levels defined by median split (see page 206) and support was defined by four levels ranging from no problem to major problem. Auxiliary coping at follow-up was entered as the dependent variable, and auxiliary coping at baseline was entered as the covariate.

Results showed a significant main effect for shiftwork locus of control on auxiliary coping at follow-up ($F(1, 389) = 5.38$, $p < .05$), after controlling for the effect of auxiliary coping at baseline ($F(1, 389) = 83.79$, p

< .001). More specifically, employees showed more auxiliary coping in the high internal control group (M = .45, SD = .05) as compared to the low internal control group (M = .47, SD = .06), with .29 SD separating the average scores, suggesting that employees with higher levels of internal control tended to utilize more auxiliary coping.

Similarly, as predicted a significant main effect was found for spouse/partner support on auxiliary coping ($F(3, 389) = 4.64$, $p < .01$) after controlling for the effect of adjustment at baseline as noted above. Specifically, those employees who thought that their spouse's/partner's level of understanding and emotional support was not a problem showed better auxiliary coping (M = .46, SD = .05) than those employees reporting spouse/partner support levels as a slight problem (M = .46, SD = .05), a moderate problem (M = .49, SD = .06), or a major problem (M = .50, SD = .08), with employees using less auxiliary coping as support diminished (note, the difference between the no problem and slight problem levels was too small to be depicted when rounding to two decimal places).

Bonferroni adjusted pairwise comparisons of support levels on auxiliary coping based on estimated marginal means (see Table 26) showed significant differences in the predicted direction for the no problem/moderate problem pairing, $p < .05$. ANCOVAs did not yield a significant interaction between support and control on auxiliary coping ($F(3, 389) = 2.30$, $p = .08$), with power to detect the interaction equal to .58.

Although not significant overall, the relationship — displayed using

using model-predicted estimated marginal mean plots (see Figure 19, page 285) — illustrates that the buffering effect of high internal

Table 26. Bonferroni Adjusted Pairwise Comparison of Spouse/Partner Support on Auxiliary Coping

Pairwise Comparisons

Dependent Variable: AX

(I) Spouse/partner support	(J) Spouse/partner support	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	Upper Bound
no problem	slight problem	.003	.006	1.000	-.013	.018
	moderate problem	-.026*	.009	.015	-.048	-.003
	major problem	-.023	.011	.253	-.053	.007
slight problem	no problem	-.003	.006	1.000	-.018	.013
	moderate problem	-.028*	.009	.015	-.053	-.004
	major problem	-.026	.012	.199	-.057	.006
moderate problem	no problem	.026*	.009	.015	.003	.048
	slight problem	.028*	.009	.015	.004	.053
	major problem	.003	.013	1.000	-.033	.038
major problem	no problem	.023	.011	.253	-.007	.053
	slight problem	.026	.012	.199	-.006	.057
	moderate problem	-.003	.013	1.000	-.038	.033

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

shiftwork locus of control was particularly evident for those employees reporting major spouse/partner support problems. This pattern is consistent with significant interaction effects previously described for spouse/partner support and control on overall adjustment, psychological health, overall physical adjustment, and physical health.

More specifically, descriptive statistics indicate that the overall buffering effect of high internal control was especially pronounced when spouse/partner support was perceived to be a major problem (M = .45, SD

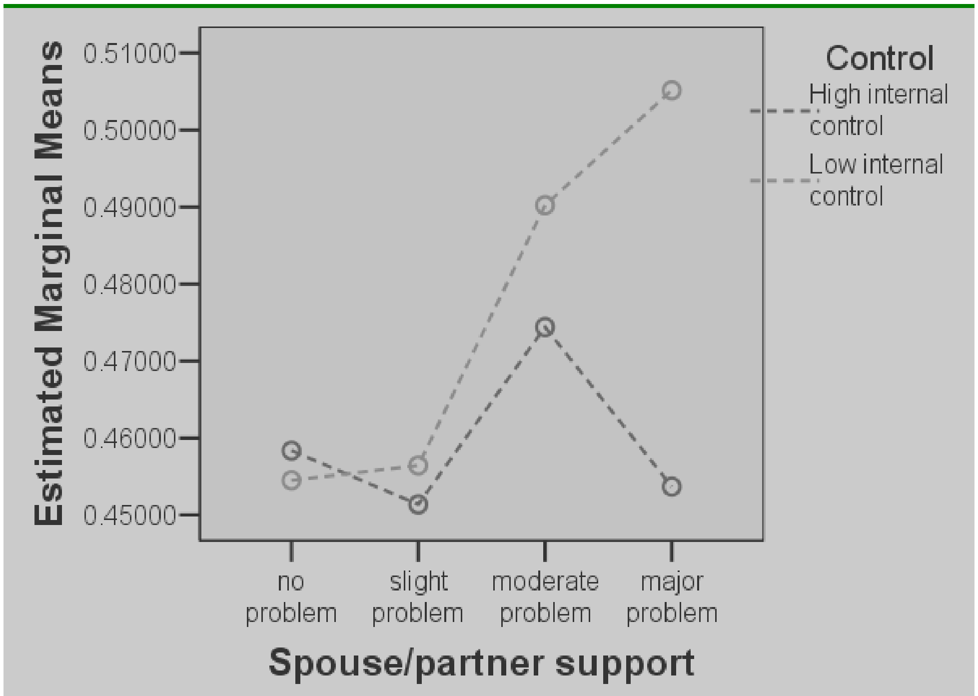


Figure 19. Relationship Between Spouse/Partner Social Support and Shiftwork Locus of Control in Predicting Auxiliary Coping.

= .06) as compared to the low internal control group (M = .52, SD = .08), with an average difference between subgroups of approximately .87 SD, a large mean difference effect (Cohen, 1988). Thus for spouse/partner relationships that were reported as significantly problematic in terms of employee-perceived support, lower internal shiftwork locus of control yielded substantially less utilization of auxiliary coping, underscoring the likely combined value of both greater levels of spouse/partner support and higher internal levels of shiftwork locus of control in predicting more use of auxiliary coping, even given the lack of a significant interaction overall between shiftwork locus of control and spouse/partner support on auxiliary coping.

Thus, results from tests A, B, and C identified auxiliary coping (but not adaptive coping or approach coping) as a potential mediator between shiftwork locus of control and adjustment, and between spouse/partner support and adjustment, but not between the overall interaction of control and support on adjustment. Accordingly, ANCOVAs were next conducted to test condition D – that the impact of the predictor (either control or support) on adjustment after controlling for auxiliary coping was less than the significant association between the predictor and adjustment without controlling for auxiliary coping.

ANCOVAs showed a significant main effect for shiftwork locus of control on the present study's composite measure of adjustment at follow-up ($F(1, 297) = 33.66$, $p < .001$) after controlling for the effects of auxiliary coping ($F(1, 297) = 3.42$, $p = .07$) and baseline adjustment ($F(1, 297 = 71.30$, $p < .001$). As predicted, ANCOVAs conducted without controlling for the mediating effects of auxiliary coping found a greater main effect for shiftwork locus of control on adjustment at follow-up ($F(1, 342) = 48.47$, $p < .001$), after controlling for the effect of adjustment at baseline ($F(1, 342) = 84.00$, $p < .001$), thus supporting auxiliary coping's mediating role in predicting the effect of shiftwork locus of control on adjustment.

Along the same lines, a main effect found for spouse/partner support on adjustment ($F (3, 342) = 33.48$, $p < .01$) after controlling for the effect of adjustment at baseline ($F (1, 342) = 84.00$, $p < .001$) was greater than the main effect found for spouse/partner support on adjustment ($F (3, 297) = 26.00$, $p < .001$) at follow-up after controlling for the effects of auxiliary coping ($F (1, 297) = 3.42$, $p = .07$) and baseline adjustment ($F (1, 297) = 71.30$, $p < .001$), supporting auxiliary coping's mediating role in predicting the effect of spouse/partner support on adjustment.

Summary of Results Relating to Hypothesis 9

ANCOVAs were conducted and identified two paths of mediation relating to both spouse/partner support and shiftwork locus of control effects on composite adjustment, each satisfying the four requirements of mediation as described by Baron and Kenny (1986). The two paths involved auxiliary coping mediating the relationships between shiftwork locus of control and adjustment as well as between spouse/partner support and adjustment. (see Figure 20).

1. Shiftwork Locus of Control ⟶ Auxiliary Coping ⟶ Adjustment

2. Spouse/Partner Support ⟶ Auxiliary Coping ⟶ Adjustment

Figure 20. Auxiliary Coping as Mediator Between Control and Adjustment and Between Support and Adjustment.

Exploratory Moderating Effects Relating to Hypothesis 10

A series of ANCOVAs were conducted to explore differences in adjustment outcomes relating to exploratory variables of interest including gender, ethnicity, age, and years of shiftwork (see Hypothesis 10, page 137). More specifically, ANCOVAS tested unique and combined effects of gender and ethnicity as well as age and years of shiftwork on the present study's composite measure of adjustment. Next, exploratory analyses also tested whether the unique and combined effects of gender and ethnicity as well as age and years of shiftwork moderated the effect of schedule demand on adjustment.

Exploratory variables were parsed into two subgroups, including gender (female/male), ethnicity (African American/Caucasian), age (< 45 years/≥ 45 years), and years of shiftwork (< 15 years/ ≥ 15 years). Each exploratory variable was input as a fixed factor in one of two separate analyses testing for a gender/ethnicity interaction as well as an age/years of shiftwork interaction. Adjustment served as the dependent variable, with corresponding baseline adjustment functioning as the covariate.

Age and Years of Shiftwork

Effects on Composite Adjustment

ANCOVAs were conducted and found no significant main effect for age on adjustment at follow-up ($F(1, 404) = .03$, $p = .86$), after controlling for the effect of adjustment at baseline ($F(1, 404) = 149.28$, $p < .001$). Nor was a significant main effect found for years of shiftwork on adjustment (F

(1, 404) = 1.98, p = .16) after controlling for the significant effect of adjustment at baseline as noted above. As well, no significant interaction effect was observed between age and years of shiftwork on adjustment (F (1, 400) = .56, p = .46) after controlling for the effect of adjustment at baseline. The power to detect differences relating to age, years of shiftwork, or their interaction was low at .05, .29, and .12, respectively.

Moderating Effects on Schedule Demand

No significant interaction effects were found for age and schedule demand on adjustment at follow-up (F (1, 373) = .96, p =.33) after controlling for the effect of adjustment at baseline (F (1, 373) = 127.75, p < .001). Nor was a significant interaction found for years of shiftwork and schedule demand on adjustment (F (1, 373) = 1.11, p =.29) after controlling for adjustment at baseline as described above. As well, no significant interaction was found among age, years of shiftwork, and schedule demand on adjustment (F (1, 373) = 1.85, p = .18) after also controlling for adjustment at baseline. The power to detect these differences was low at .16, .18, and .27, respectively.

Gender and Ethnicity

Effects on Composite Adjustment

ANCOVAs were conducted and showed a significant main effect for gender on adjustment at follow-up (F (1, 400) = 4.46, p < .05), after controlling for the effect of adjustment at baseline (F (1, 400) = 155.45, p < .001). More specifically, females (M = .13, SD = 3.35) showed significantly poorer overall adjustment than males ($M = -.66$, $SD = 3.98$), with .21 SD separating the average scores. This weak — albeit significant — mean difference effect size (Cohen, 1988) suggests that female employees in the present study experienced slightly diminished overall adjustment as compared to male employees.

No significant main effect was found for ethnicity on overall adjustment ($F(1, 400) = 1.61$, $p = .205$) after controlling for the significant effect of adjustment at baseline as noted above. The power to detect differences was low at .25. As well, no significant interaction effect was observed between gender and ethnicity on adjustment ($F(1, 400) = .08$, $p = .78$) after controlling for the effect of adjustment at baseline as described previously. The power to detect an interaction was very low at .06.

Moderating Effects on Schedule Demand

No significant interaction effects were found for gender and schedule demand on adjustment at follow-up ($F(1, 368) = .56$, $p = .46$) after controlling for the effect of adjustment at baseline ($F(1, 368) = 123.37$, $p < .001$). Nor was a significant interaction found for ethnicity and schedule demand on adjustment ($F(1, 368) = .62$, $p = .43$) after controlling for adjustment at baseline as described above. As well, no significant interaction was found among gender, ethnicity, and schedule demand on adjustment ($F(1, 368) = .08$, $p = .77$) after also controlling for adjustment at baseline. The power to detect these differences was very low at .12, .12, and .06, respectively.

Summary or Results Relating to Hypothesis 10

Exploratory ANCOVAs were conducted to test for unique and combined effects of age and years of shiftwork as well as gender and ethnicity on composite adjustment. A significant main effect was found for gender on the present study's composite measure of adjustment, with males showing slightly better overall adjustment than females. Exploratory ANCOVAs were also conducted to test unique and combined effects of both age and years of shiftwork as well as gender and ethnicity as moderators of schedule demand's significant effect on adjustment. No significant moderating effects on demand were observed for either age and years of shiftwork or gender and ethnicity.

Exploratory Demand-Control-Support Conceptualization

Multiple linear regression analyses were conducted to evaluate the robustness of the proposed demand-control-support framework presented in Chapter 4 (see Karasek's Demand-Control Model Expanded to include Spouse/Partner Support, page 121) as compared to the demand-control formulation without spouse/partner support. The analyses then compared R^2_{adj} to see whether or not the proposed demand-control-support conceptualization better accounted for adjustment outcomes.

First, the analysis examined how the two regressors of schedule demand and shiftwork locus of control, taken together, explained the variation in the dependent variable measure of composite adjustment. Then, the analysis assessed whether or not the two regressors taken together were significantly associated with adjustment. Next, multiple regression examined how the three proposed regressors of schedule demand, shiftwork locus of control, and spouse/partner support, taken together, explained the variation in the dependent variable measure of composite adjustment. Following this, the analysis also assessed whether or not the three proposed regressors taken together were significantly associated with adjustment.

Results for the multiple regression of composite adjustment with schedule demand and shiftwork locus of control as regressors showed that the regression was an adequate fit (R^2_{adj} = .51, see Table 27, Model 1, page 293). Note, adjusted R squared was utilized because, as indicated via SPSS' Release 13.0 context-sensitive help menu, "The sample R squared tends to optimistically estimate how well the model fits the population. The model usually does not fit the population as well as it fits the sample from which it is derived. Adjusted R squared attempts to correct R squared to more closely reflect the goodness of fit of the model in the population." Thus R^2_{adj} represents a slightly more conservative estimate of model fit.

Because R^2_{adj} can be viewed as the proportion of total variation in adjustment accounted for by the regressors, the combined effects of shiftworker locus of control and schedule demand thus accounted for 51% of the variability in the composite adjustment outcome measure. In an improved model, however, results for the multiple regression of composite adjustment with schedule demand, shiftwork locus of control, and spouse/partner support as proposed regressors showed that this three-predictor regression was a better fit (R^2_{adj} = .63, see Table 27, Model 2). The combined effects of schedule demand, shiftworker locus of control, and spouse/partner support accounted for 63% of the variability in the composite adjustment measure. Thus, the demand-control-support model explained 12% more variability in adjustment and thus seems an appropriate grouping towards better understanding adjustment outcomes.

Table 27. Results for Multiple Linear Regressions with and without Spouse/Partner Support to Explore Expanded Demand-Control-Support Conceptualization

Model 1: Adjustment Regressed on Demand and Control

Model	R	R Square	Adjusted R Square
1	.715[a]	.511	.509

a. Predictors: (Constant), Dmd, Ctrl

Model 2: Adjustment Regressed on Demand, Control, and Support

Model	R	R Square	Adjusted R Square
2	.796[a]	.634	.631

a. Predictors: (Constant), Dmd, Supp, Ctrl

The linear relationship for the demand-control-support framework is also illustrated in Figure 21, which depicts adjustment as a function of the regression standardized predicted values using a line-of-best fit to portray the association. The overall relationships were significant both in model 1 ($F(3, 373) = 215.10$, $p < .001$) and model 2 ($F(2, 424) = 221.73$). The regression equation that estimates the standardized linear association of demand, control, and support regressors on adjustment follows the general form: $y = \beta 0 + \beta 1x1 + \beta 2x2 + \varepsilon$, where the parameter β is the constant and both $\beta 1$ and $\beta 2$ represent slopes, and is presented below:

Adjustment = *.39(Control)* + *35(Support)* + *.31(Demand) -12.34*

Adjustment functions as the DV, control, support, and demand each function as an IV preceded by their corresponding regression coefficient, and -12.34 serves as a constant.

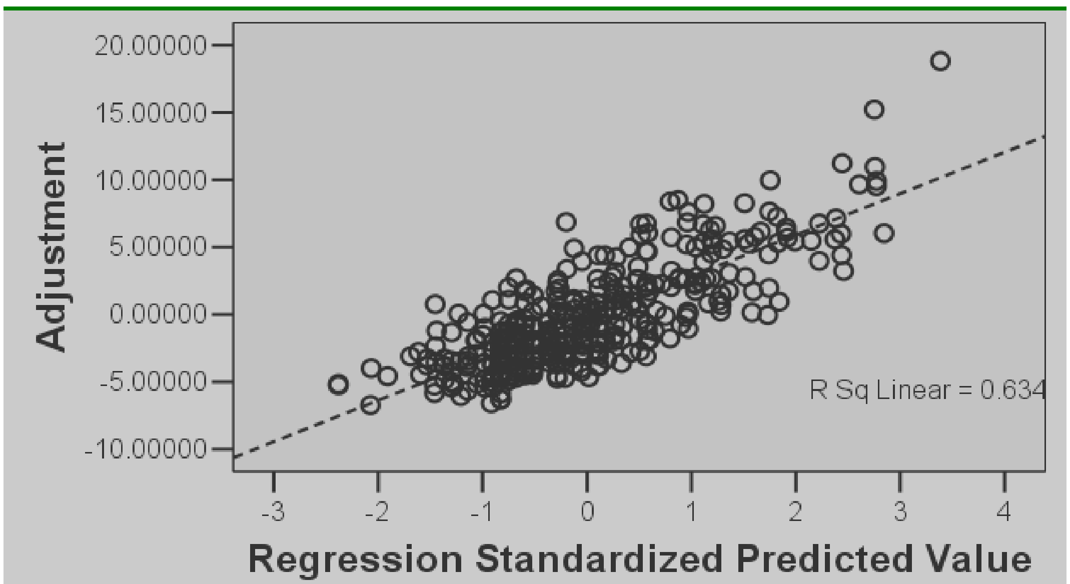
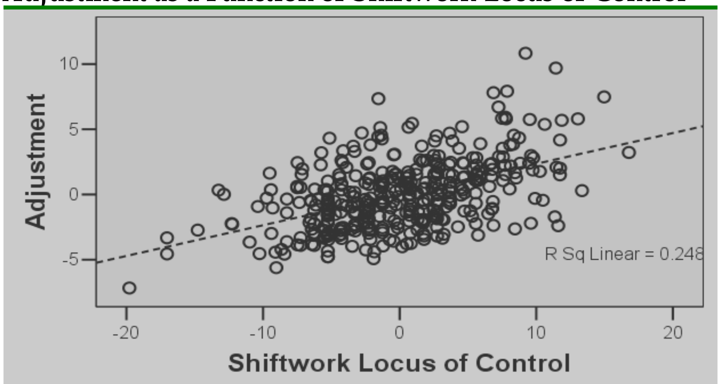


Figure 21. **Scatterplot and Line-of-Best-Fit for Multiple Regression of Adjustment on Demand, Control, and Support.**

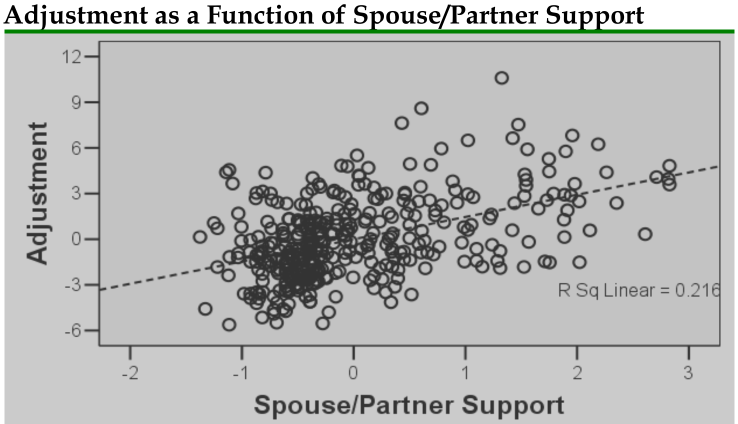
With other variables held constant, adjustment scores were positively related to the three tested regressors, increasing by .39, .35, and .3 for every standardized unit increase in shiftwork locus of control, spouse partner support, and schedule demand, respectively, suggesting that control was most associated with adjustment, followed by support and then demand when controlling for other variables. Additionally, with all other variables taken into account, the three tested regressors were each significantly associated with adjustment, including control (t (373) = 11.09, $p < .001$), support (t (373) = 10.13, $p < .001$), and demand (t (373) = 8.50, $p < .001$).

Moreover, both partial (.50, .46, .40) and part correlations (.35, .32, .27) for control, support, and demand, respectively, further reflected their relationships to adjustment, where partial correlations presented the separate correlation between each of the demand, control, and support regressors with adjustment after removing the linear effect of variables already in the model, while part (or semipartial) correlations presented the correlation between adjustment and either demand, control, or support after the linear effects of the other two IV's in the model was removed from the remaining IV (see Figure 22, page 296). To graphically illustrate the effects of each independent variable on the model, partial residual plots were rendered and are presented in Figure 22.

Adjustment as a Function of Shiftwork Locus of Control



Adjustment as a Function of Spouse/Partner Support



Adjustment as a Function of Schedule Demand

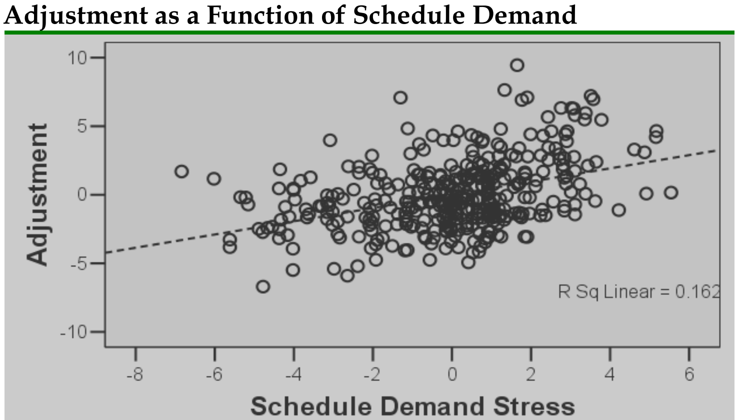


Figure 22. Partial Regression Plots for Adjustment as a Function of Control, Support, and Demand.

Integrative Structural Equation Models

LISREL analyses (Joreskog and Sorbom, 1993) with latent variables were conducted to combine linear structural relationships and factor structures to test both direct and hypothesized mediational models. In addition to examining the expected paths predicted by the present study's longitudinal model (see Figures 2 and 3, pages 110 and 111, respectively) LISREL also tested the goodness of fit for the integrative models.

Analyses first explored the hypothesized model with no paths mediating between predictors and adjustment, allowing for examination of direct paths from demand, control, and support to the latent, theoretical variable of change in adjustment (Figure 23, page 301). LISREL then examined the predictive model integrating coping as a mediator between predictors and adjustment to further test mediational relationships in the structural equation model. Paths were systematically removed from the saturated model to allow for post hoc comparative testing of model parameters. Paths that did not significantly improve model fit were deleted. The final model (Figure 24, page 304) reflects the best model fit.

Following previous research (Holahan & Moos, 1987) the LISREL analyses provided a conservative test of the models by controlling for the influence of baseline adjustment on outcome adjustment. Applying prior research (Holahan, Moos, Holahan, & Cronkite, 1999, 2000; Valentiner, Holahan, & Moos, 1994), to index change in adjustment across the 12 months following initiation of an employee-driven schedule selection process (schedules were implemented approximately 4 months subsequent to the start of the change process), the endogenous variable for change in adjustment was indexed by the residuals from the simple regressions of each outcome indicator on the respective indicator at baseline. For example, performance (Perf) at Time 2 was regressed on performance at Time 1 (bPerf), and residuals were saved as one of three variables indicating latent change in adjustment in the LISREL analyses.

Goodness of Fit: Direct and Mediational Models

Chi square yielded disparate results for fitting the model to the sample data ($\chi 2$ (6, N = 603) = 37.0, $p < .001$; $\chi 2$ (15, N = 603) = 122.3, $p < .001$) for the direct and mediational models, respectively. However, considerations concerning goodness of fit, particularly given the present study's relatively large sample size, suggest that chi square is not the best measure of fit in the present context due to the large sample size (see Joreskog, 1969; Bentler & Bonett, 1980; Browne & Mels, 1992). For example, Joreskog (1969) noted some time ago that, "Such a hypothesis (of perfect fit) may be quite unrealistic in most empirical work with test data. If a sufficiently large sample were obtained this chi square statistic would, no doubt, indicate that any such nontrivial hypothesis is statistically untenable."

More recently, Browne & Mels (1992) suggested that, "Our opinion... is that this null hypothesis (of perfect fit) is implausible and that it does not help much to know whether or not the statistical test has been able to detect that it is false." Others engaged in applying structural equation modeling to stress and coping, adjustment, and performance research (e.g., Aspinwall & Taylor, 1992) have made similarly informed decisions to utilize other goodness-of-fit tests such as Bentler's (1990) Comparative Fit Index (CFI), "…because the chi-square goodness-of-fit test is sensitive to even trivial differences between the data and the model covariance matrix in large samples." Accordingly, with the present study's gross sample size of 603 employees having met subject validity criteria, a similarly informed decision was made to utilize other multiple goodness-of-fit indices to gauge support for the predictive model.

Table 28 (page 300) presents test results for several indices applicable for testing goodness of fit in structural equation models (Arbuckle, 2005). These indices include Bentler-Bonnett's (Bentler & Bonett, 1980) Normed Fit Index (NFI), Bollen's (Bollen, 1986) Relative Fit Index (RFI), Bollen's (Bollen, 1989b) Incremental Fit Index (IFI), the Tucker-Lewis Coefficient, also known as the Bentler-Bonnett Non-normed Fit Index (NNFI), and the Comparative Fit Index (CFI; Bentler, 1990). In the latter CFI, for example, the index measure the relative sufficiency of a model on a continuum of models ranging from the null model where variables are unrelated to a saturated model in which all study variables are related. An index score of 1 would signify a perfect fit of the model to the data.

The CFI for the direct path model produced a rating of .967, indicating an acceptable fit. Furthermore, the indices taken together broadly support the model fit (values range from 0 to 1 with values close to 1.0 indicating a good fit of the model to the data). The direct model's values for the five indices below ranged from .89 to .97, indicating good consensus across the five indices for an adequate fit, with an average index score of .94. As well, the mediational model (Table 28, page 300) scored above .90 on three of the five test indices, suggesting an acceptable fit across the majority of indices explored, with an average index score of .87.

Table 28. Results of Goodness of Fit Tests for Direct and Mediational LISREL Models

LISREL MODEL	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Direct Model	.967	.885	.972	.902	.972
Mediational Model	.915	.795	.924	.816	.923

Direct Path Model

There were three exogenous observed variables in the model (schedule demand, shiftwork locus of control, and spouse/partner support). There was one unobserved endogenous variable (latent adjustment) at outcome indexed by three observed indicators (residuals from the simple regressions of psychological, physical, and performance on their respective indicator at baseline to control for the influence of baseline adjustment on outcome adjustment). To provide a metric for the latent construct and to identify the measurement model, the performance indicator loading for the latent construct adjustment was set to 1.0 in the unstandardized solution for the model. The model was identified and minimums were achieved. Analyses produced an inter-item covariance matrix to test the strength of associations among the indicator variables of demand, control, and support and the latent variable of adjustment along with its respective indicators.

Predictive Relationships

The direct path LISREL model is depicted graphically below with standardized estimates (Figure 23). Of particular interest was whether the

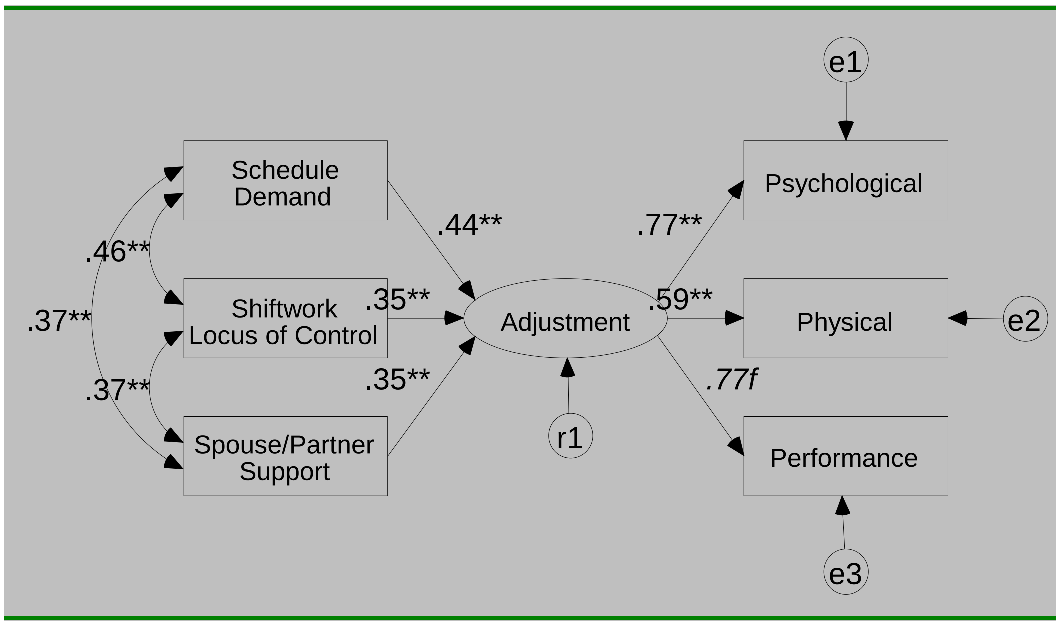


Figure 23. Direct path model: Results of the LISREL test (standardized estimates) of the integrative structural equation model for the direct paths from predictors to the latent dependent variable adjustment. To control for the influence of baseline adjustment on outcome adjustment, the endogenous variable for change in adjustment was indexed by the residuals from the simple regressions of each outcome indicator on the respective indicator at baseline (N = 603). (e^n represents unique variance in the corresponding observed variable; r^n represents residual variance in the corresponding latent variable; an italicized *f indicates a* fixed parameter. **p<.01.)

predictors made unique contributions on adjustment, and whether such contributions were significant in the integrative model. Direct paths from schedule demand, shiftwork locus of control, and spouse/partner support to the latent variable of change in adjustment were hypothesized, and as depicted in Figure 23, each of the three predictors had direct positive associations with subsequent adjustment after controlling for the influence of adjustment at baseline. For example, when spouse/partner support goes up by one SD, the latent variable change in adjustment goes up by .35 SD.

Moreover, the factor loadings for the indicators of change in psychological health, change in physical health, and change in performance variables illustrate that each measure reliably indicates the latent variable of change in adjustment. For example, when change in adjustment goes up by 1 SD, change in psychological adjustment goes up by .77 SD. Similarly, as change in adjustment goes up by 1 SD, physical adjustment and performance increase by .59 and .77 SD, respectively. Overall, the predictors of adjustment (schedule demand, shiftwork locus of control, and spouse/partner support) were estimated (R^2) to explain 78.3% of its variance, thus error represents approximately 21.7% of the variance in change of adjustment in the direct LISREL model.

Mediational Model

There were three exogenous observed variables in the model (schedule demand, shiftwork locus of control, and spouse/partner support). There was one unobserved endogenous variable (latent adjustment) at outcome indexed by three observed indicators (residuals from the simple regressions of psychological, physical, and performance on their respective indicator at baseline to control for the influence of baseline adjustment on outcome adjustment). There was also a latent variable at outcome included in the model as a mediator (adaptive coping), indexed by two observed indicators (approach and auxiliary coping). To provide a metric for the latent construct and to identify the measurement models, the performance indicator loading for the latent construct adjustment as well as the auxiliary indicator for the latent construct adaptive coping were set to 1.0 in the unstandardized model solutions. The model was identified and minimums were achieved. Analyses produced an inter-item covariance matrix to test the strength of associations among the indicator variables of demand, control, and support, and their integrative relationships to latent adaptive coping and latent adjustment along with their respective indicators.

Predictive Relationships

The mediational model, depicted graphically with standardized estimates (Figure 24 below), explored the integrative, longitudinal model to test for combined relationships among predictors. Two paths were deleted from the mediational model: the indirect path from schedule demand to adaptive coping because it did not significantly improve model

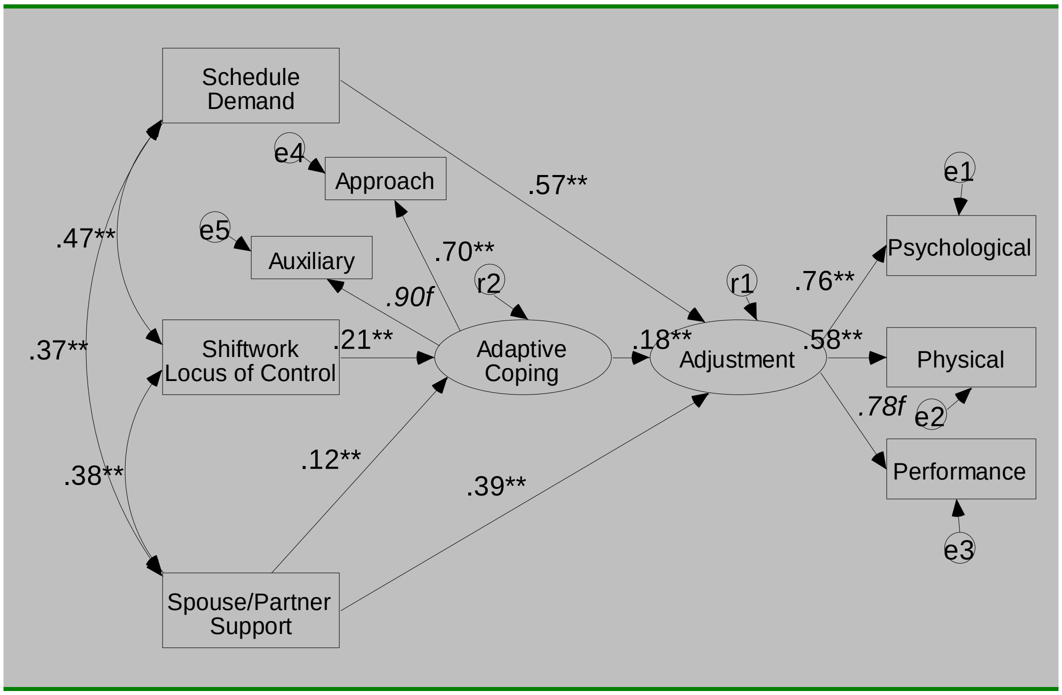


Figure 24. Mediational model: Results of the LISREL test (standardized estimates) of the integrative structural equation model for the mediating and direct paths from predictors to the latent dependent variable adjustment. To control for the influence of baseline adjustment on outcome adjustment, the endogenous variable for change in adjustment was indexed by the residuals from the simple regressions of each outcome indicator on the respective indicator at baseline (N = 603). (e^n represents unique variance in the corresponding observed variable; r^n represents residual variance in the corresponding latent variable; an italicized *f indicates a* fixed parameter. *p<.05, **p<.01.)

fit ($\chi 2$ (1, N = 603) = 2.4, p > .05), and the direct path from control to adjustment because inclusion of the path resulted in an unacceptable solution.

As illustrated in Figure 24, each predictor operates through different pathways in the integrative, mediational model. Specifically, schedule demand relates to change in adjustment directly but not through mediating adaptive coping processes in the integrative model. In contrast, shiftwork locus of control relates to change in adjustment indirectly through mediating coping but not directly in the integrative design. Different still, spouse/partner support relates to adjustment through both direct and indirect mechanisms.

For example, when support goes up by 1 SD, change in adjustment goes up directly by .39 SD. At the same time, adaptive coping goes up by .12 SD in response to spouse/partner support, adding to the overall link between spouse/partner support and change in adjustment since latent adjustment also goes up .18 SD for every increase of 1 SD in adaptive coping. Interestingly, when schedule demand goes up by 1 SD, latent change in adjustment directly increases by .57 SD. Control, on the other hand, relates to latent change in adjustment indirectly through adaptive coping in the mediational model, and for every 1 SD increase in control, adaptive coping rises by .21 SD.

Similar to the prior LISREL model assessing only direct paths, the factor loadings for the indicators of change in psychological health, change in physical health, and change in performance variables in the mediational model further illustrate that each measure reliably indicates the latent variable of change in adjustment. For example, when latent change in adjustment goes up by 1 SD, change in psychological adjustment goes up by .77 SD. As well, as change in adjustment goes up by 1 SD, physical adjustment and performance both increase by .58 and .78 SD, respectively.

Adaptive coping relates to latent change in adjustment as previously mentioned with a 1 SD change for every .18 SD change in adjustment. At a more specific level, when adaptive coping goes up by 1 SD, percent of auxiliary coping goes up by .90 SD whereas percent of approach coping goes up by .70 SD. Looking globally at the integrative model overall, the predictors of adjustment (schedule demand, shiftwork locus of control, spouse/partner support, and mediating auxiliary and approach coping) were estimated to explain 72.8% (R^2) of its variance, thus error represents approximately 27.2% of the variance in change of adjustment in the mediational, integrative LISREL model.

Supplemental LISREL Models

Building on relationships observed in the present study, Figures 25 through 27 present three supplemental LISREL models for further consideration. Models include a direct path with schedule preference as a predictor of latent adjustment, a mediational model with schedule demand as a mediator between preference and latent adjustment, and a direct path model with schedule demand as one of four outcome indicators. Chi square yielded mixed results for fitting these three models to the sample data ($\chi2$ (2, N = 603) = 1.53, p = .464; $\chi2$ (4, N = 603) = 25.09, p < .001); $\chi2$ (8, N = 603) = 4.68, p < .001), respectively. Thus, the direct path with schedule demand as a predictor of latent adjustment appears to be a strong model fit even using only chi square as a test, in contrast to the other two supplemental models. However, as previously discussed, chi square is not the best measure of fit in the present context due to the large sample size (see Joreskog, 1969; Bentler & Bonett, 1980; Browne & Mels, 1992).

Furthermore, the goodness of fit test indices displayed in Table 29 strongly and broadly support the fit of all three supplemental models.

Table 29. Results of Goodness of Fit Tests for Supplemental LISREL Models

LISREL MODEL	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Direct Model with Schedule Preference as Predictor	.996	.982	1.00	1.01*	1.00
Mediational Model with Schedule Demand as Mediator	.967	.875	.972	.893	.971
Direct Model with Schedule Demand as Outcome Indicator	.959	.891	.965	.908	.965

*Arbuckle (2005) notes, "the typical range for TLI lies between zero and one, but it is not limited to that range. TLI values close to 1 indicate a very good fit."

Direct Model with Schedule Preference as Predictor

The direct model with schedule preference as the predictor is depicted graphically with standardized estimates (Figure 25). There was one exogenous observed variable in the model (schedule preference). There was one unobserved endogenous variable (latent adjustment) at outcome indexed by three observed indicators (residuals from the simple regressions of psychological, physical, and performance on their respective indicator at baseline to control for the influence of baseline adjustment on outcome adjustment). To provide a metric for the latent construct and to identify the measurement model, the performance indicator loading for the latent construct adjustment was set to 1.0 in the unstandardized solution for the model. The model was identified and minimums were achieved. Analyses produced an inter-item covariance matrix to test the strength of associations among the indicator variable of schedule preference and the latent variable of adjustment along with its respective indicators.

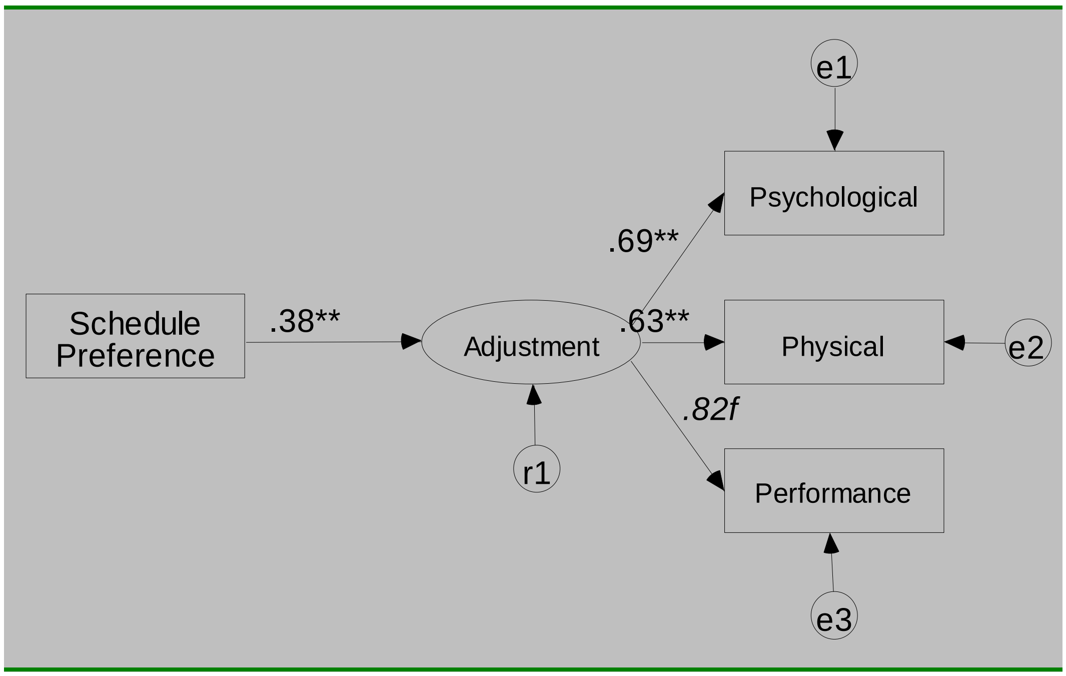


Figure 25. Supplemental direct path model with schedule preference as predictor: Results of the LISREL test (standardized estimates) of the structural equation model for the direct path from a predictor to the latent dependent variable adjustment. To control for the influence of baseline adjustment on outcome adjustment, the endogenous variable for change in adjustment was indexed by the residuals from the simple regressions of each outcome indicator on the respective indicator at baseline (N = 603). (e^n represents unique variance in the corresponding observed variable; r^n represents residual variance in the corresponding latent variable; an italicized *f indicates a* fixed parameter. **p<.01.)

Of particular interest was the extent to which schedule preference made significant contributions to latent adjustment. As seen in Figure 25, when schedule preference goes up by one SD, the latent variable change in adjustment goes up by .38 SD. Moreover, the factor loadings for the indicators of change in psychological health, change in physical health, and change in performance variables illustrate that each measure reliably indicates the latent variable of change in adjustment. Overall, schedule preference was estimated (R^2) to explain 14.1% of the variance in latent adjustment, thus error represents approximately 85.9% of the variance in change of adjustment in this supplemental direct LISREL model.

Mediational Model with Schedule Demand as Mediator

The mediational model with schedule schedule demand as a mediator between preference and latent adjustment is depicted graphically with standardized estimates (Figure 26). There was one exogenous observed variable in the model (schedule preference). There was one unobserved endogenous variable (latent adjustment) at outcome indexed by three observed indicators (residuals from the simple regressions of psychological, physical, and performance on their respective indicator at baseline to control for the influence of baseline adjustment on outcome adjustment). There was also an observed variable at outcome included in the model as a mediator (schedule demand as a time 2 measure comparing demand at time 2 to time 1). To provide a metric for the latent construct and to identify the measurement models, the performance indicator loading for the latent construct adjustment was set to 1.0 in the unstandardized model solution. The model was identified and minimums were achieved. Analyses produced an inter-item covariance matrix to test the strength of associations among the indicator variable of schedule preference, and its integrative relationships to schedule demand and latent adjustment along with the adjustment's respective indicators.

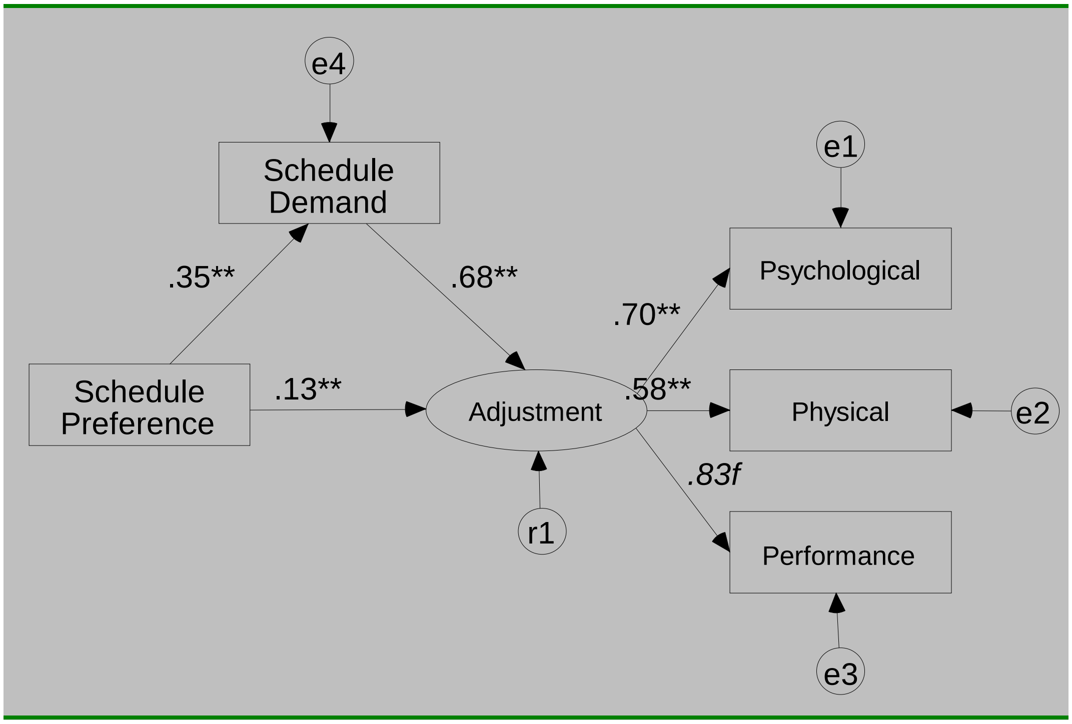


Figure 26. Supplemental mediational model with schedule demand as mediator: Results of the LISREL test (standardized estimates) of the integrative structural equation model for the mediating and direct paths from the predictor to the latent dependent variable adjustment. To control for the influence of baseline adjustment on outcome adjustment, the endogenous variable for change in adjustment was indexed by the residuals from the simple regressions of each outcome indicator on the respective indicator at baseline (N = 603). (e^n represents unique variance in the corresponding observed variable; r^n represents residual variance in the corresponding latent variable; an italicized *f indicates a* fixed parameter. **p<.01.)

Of particular interest was the extent to which schedule demand mediated the relationship between preference and latent adjustment. As illustrated in Figure 26, schedule preference relates to adjustment through both direct and indirect mechanisms; however, the stronger relationship between preference and adjustment is indirectly through schedule demand.

Specifically, when preference goes up by 1 SD, change in adjustment goes up directly by .13 SD. At the same time, schedule demand goes up by .35 SD in response to preference, adding substantially to the overall link between preference and change in adjustment since latent adjustment also goes up .68 SD for every increase of 1 SD in schedule demand.

The factor loadings for the indicators of change in psychological health, change in physical health, and change in performance variables in the supplemental mediational model further suggest that each measure reliably indicates the latent variable of change in adjustment. Looking at he integrative model overall, the predictors of adjustment (preference and mediating schedule demand) were estimated to explain 54.2% (R^2) of its variance, thus error represents approximately 45.8% of the variance in change of adjustment in this mediational, integrative LISREL model.

Direct Model with Schedule Demand as Outcome Indicator

The direct model with schedule preference as one of four outcome indicators is depicted graphically with standardized estimates (Figure 27). There were two exogenous observed variables in the model (shiftwork locus of control and spouse/partner support). There was one unobserved endogenous variable (latent adjustment) at outcome indexed by four observed indicators (residuals from the simple regressions of psychological, physical, and performance on their respective indicator at baseline to control for the influence of baseline adjustment on outcome adjustment, as well as a comparative measure of schedule demand taken at time 2 to assess time 2 demand as compared to time 1 demand). To provide a metric for the latent construct and to identify the measurement models, the psychological indicator loading for the latent construct adjustment was set to 1.0 in the unstandardized model solution. The model was identified and minimums were achieved. Analyses produced an inter-item covariance matrix to test the strength of associations among the indicator variables of control and support, and their integrative relationships to latent adjustment along with its respective indicators.

Of particular interest was the extent to which schedule demand functions as an outcome indicator; that is, to what extent did the scheduling intervention change demand over time as tapped by alertness at work, at home, and while driving between work and home when assessed at time 2 in relation to time 1. As illustrated in Figure 27, the factor loadings for all four outcome indicators suggest that each measure reliably indicates the latent variable of adjustment. Interestingly, when latent adjustment goes up by 1 SD, schedule demand goes up by .70 SD, comparable to the .60 SD, .78 SD, and .77 SD simultaneous increases in physical adjustment, performance, and psychological adjustment, respectively. Thus, findings strength support for alternatively characterizing schedule demand as an outcome indicator.

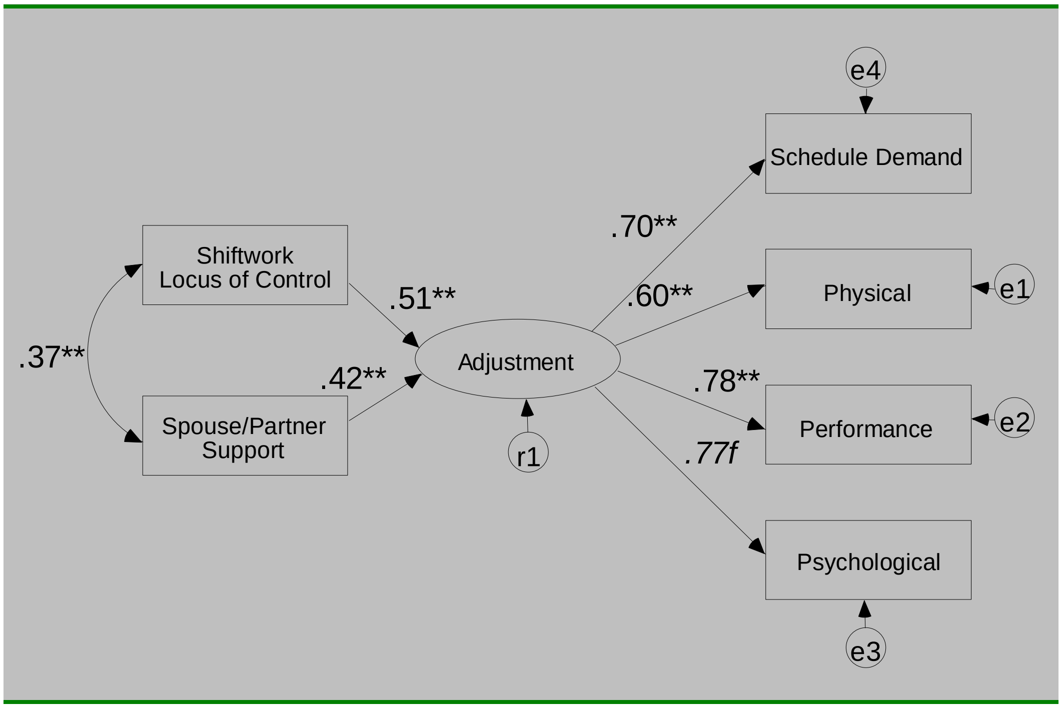


Figure 27. Supplemental direct path model with schedule demand as additional outcome indicator: Results of the LISREL test (standardized estimates) of the integrative structural equation model for the mediating and direct paths from predictors to the latent dependent variable adjustment. To control for the influence of baseline adjustment on outcome adjustment, the endogenous variable for adjustment was indexed by the residuals from the simple regressions of three outcome indicators on the respective indicator at baseline. As well, schedule demand served as a fourth outcome indicator and was assessed at time 2 to compare time 2 demand with time 1 demand (N = 603). (e^n represents unique variance in the corresponding observed variable; r^n represents residual variance in the corresponding latent variable; an italicized *f indicates a* fixed parameter. *p<.05, **p<.01.)

Looking at the integrative model overall, the predictors of adjustment (shiftwork locus of control and spouse/partner support) were estimated to explain 60.1% (R^2) of adjustment's variance, thus error represents approximately 39.9% of the variance in latent adjustment in this four-outcome indicator LISREL model. Although the supplemental model did not account for as great a proportion of latent adjustment's variance as either the originally proposed direct path (78.3%, see Figure 23) or mediational model (72.8%, see Figure 24), the supplemental model does suggest the value of further exploring the role of schedule demand as an outcome in the integrative design.

Summary of LISREL Results

Both direct and mediational LISREL models were tested to examine goodness of fit and predicted relationships among variables of interest while simultaneously controlling for the influence of baseline adjustment on adjustment at follow-up. Results showed that all three predictors made significant unique contributions in predicted directions to latent change in adjustment. With adaptive coping in the model, the three predictors related to change in adjustment in predicted directions, but in slightly different ways. Specifically, shiftwork locus of control related to adjustment through coping but was not directly linked to adjustment, whereas schedule demand related directly to adjustment but not through coping. Spouse/partner support worked partially through coping in relating to adjustment, and also partially through a direct path to adjustment. As well, indices of both change in adjustment and adaptive coping reliably indicate their corresponding latent, theoretical construct in predicted directions in the integrative omnibus LISREL analyses.

Additionally, supplemental models suggest that schedule demand substantially mediates the relationship between schedule preference and latent adjustment. As well, the consideration of schedule demand as an outcome indicator of latent adjustment was supported.

Chapter 7: Discussion

These results broaden our understanding of shiftwork stress resistance, health, and performance optimization in several ways. As a predictive, integrative shiftwork model of stress resistance (Antonovsky, 1987; Holahan & Moos, 1994), the findings underscore the roles of individual variability (Rahe & Arthur, 1987), personal (Cohen & Edwards, 1989) and environmental resources (Akerstedt, 1990), adaptive coping strategies (Lazarus & Folkman, 1984; Macrae, 1984), and the relationships among them (Coyne & Downey, 1991; Holahan & Moos, 1986, 1994) in predicting biopsychosocial adaptation under stress (Engel, 1977, 1980). As an intervention, the conclusions support the utility of an employee-driven (Karasek, 1979; Theorell & Karasek, 1990, 1996) schedule optimization process (Kolgi, 1991) to reduce the damaging effects of shiftwork, consistent with an impressive body of evidence (e.g., Barton et al., 1995; Costa, et al., 1995; Folkard & Monk, 1985; Scott, 1990).

The results are also consistent with two broadened and refined theoretical conceptualizations regarding mediation and prediction. First, the findings expand and refine coping taxonomy beyond traditional approach and avoidance (Carver, Scheier, & Weintraub, 1986) to include auxiliary coping (Lehrer, 1996). In the present study, auxiliary coping is defined as coping strategies that are neither approach nor avoidant and instead involve efforts to continue adaptive functioning without trying to resolve or deny the situation (e.g., humor, acceptance, religion). In the current sample, auxiliary coping mediates between schedule demand and adjustment, including indices of psychological health, performance, and safety. Second, building on previous research (Cronkite & Moos, 1984; Holahan & Moos, 1987, 1991; Heller, Swindle, & Dusenbury, 1986) the results further strengthen Karasek's (1979) demand-control model of stress and strain and the more recently expanded demand-control-job support model (Johnson, 1989; Karasek & Theorell, 1990) by integrating spouse/partner support to strengthen predictions.

HISTORICAL CONTEXT

A critical challenge of the industrialized global community has been to satisfy the growing demand for productive shiftworkers (Moskowitz, 1996) while meeting the biological, psychological, and social needs of the shiftworkers themselves (Engel, 1977, 1980, Barton, 1990). 23.8 million employees representing 17.6% of the U.S. workforce have jobs beyond 9am-5pm (Bureau of Labor Statistics, 2001), and outsourcing and downsizing has left employees with more responsibility, fewer resources, less sleep, and thus less related vigilance (McCarthy & Waters, 1997). And the number of U.S. shiftworkers is growing at a rate of approximately 3% each year (National Sleep Foundation, 2005).They also have more digestive problems (Waterhouse et al., 1992), cardiovascular disease (Knutsson, 1989), depression (Barton, 1995; Bohle & Tilley, 1989), anxiety (Costa, 1981), and divorce (McBride & Westfall, 1992). .

Reduced job alertness costs an estimated $70 billion a year (Mapes, 1990), leading to increased safety risk (Smith & Folkard, 1993; Dalbokova et al., 1995) and poorer performance (Folkard & Monk, 1979; Williamson & Feyer, 1990). Mittler et al. (1988) described sleep-debt as a critical public health and safety issue. In fact, as many as 47 million adults in the U.S. do not get adequate sleep to sustain alertness the following day (National Sleep Foundation, 2002). This is troubling since impaired and reduced sleep are frequent problems of shiftwork (Spelten et al., 1995), producing predictable lapses in alertness and performance. Not surprisingly, fatigue is considered a major cause of industrial and transportation accidents (Mackie and Miller, 1991), including Three Mile Island and Chernobyl (Ehret, 1980; Folkard, 1990).

Tying traditional stress & coping research (e.g., Seyle, 1950; Holmes & Rahe, 1967; Dohrenwend & Dohrenwend, 1981) to a well-established body of shiftwork literature (e.g., Folkard & Monk, 1979; Czeisler et al., 1980, Dinges & Kribbs, 1991, Costa, 1991; Akerstedt & Torsvall, 1981; Tepas & Carvalhais, 1990) focuses increasing interest on stress resistance (e.g., Coyne and Downey, 1991; Kessler, Price, and Wortman, 1985, Antonovsky, 1987; Holahan & Moos, 1994). Consider, for example, the shiftworker who is able to maintain effective levels of biopsychosocial adaptation even under discernible stressors.

Some individuals are better able to use personal and environmental resources as well as adaptive coping strategies to manage stressful circumstances and maintain psychosocial health, while others are less successful. Such individual differences including perceived control and support, as well as schedule demand, are tested in the current study to see if in fact they predict psychological health, physical health, and operational performance either directly or through mediating coping processes. The study further tests shiftwork scheduling and training interventions to see if they predict control, support, coping, or adjustment outcomes (Engel, 1977, 1980; Taylor, 1991) in a biopsychosocial model of health and performance.

INTEGRATIVE PREDICTIVE MODEL

Overall, results lend substantial support to the hypotheses. The three predictor variables uniquely contributed to outcomes. In an integrative framework that included coping strategies, each of these constructs also worked in unique ways. Some unexpected findings emerged with respect to coping's mediating role through auxiliary in contrast to approach coping. A strength of the present study is its broad operationalization of adjustment to include indicators of psychological health, physical health, and performance (Rowe, 1992).

To test individual hypothesized components of the model as well as the comprehensive, integrative framework, several statistical techniques are applied consistent with the study's aim for theoretical understanding (Antonovsky, 1987) and practical application (Crump, 1979; Ehret, 1980; Kolgi, 1991, Mackie & Miller, 1991). Whereas ANCOVAs provide insight by isolating and testing specific interactions from an applied perspective, LISREL analyses using latent variables (Joreskog & Sorbom, 1993) test theoretical constructs in a comprehensive mediational model.

Intervention Effects

Schedule demand, schedule preference, and shiftworker lifestyle training function differently as interventions in the current model. Consistent with previous research (e.g., Smith & Folkard, 1993; Dalbokova, 1995; Costa, 1995; Feyer and Williamson, 1995), alertness as an index of schedule demand is a strong predictor of adjustment across all indices in both the theoretical LISREL and applied ANCOVA analyses. In the structural models, demand relates to adjustment directly but not through coping, whereas control relates to adjustment only through coping. Support relates to adjustment both directly and also partially through coping.

Regarding indices of adjustment, more manageable demand indicated by improve perceived alertness relates positively to psychological health, physical health, safety, and productivity, even after controlling for corresponding adjustment measures at baseline (see Holahan and Moos, 1987). These findings are exciting given that an aim of the study is to increase alertness over time while improving adjustment. The findings also underscore the importance of individual differences in relation to perceived alertness and adjustment outcomes.

Even though certain job duties are generally seen as more stressful than others (Karasek, 1979), a theoretical rating of demand by job and schedule may be overly prescriptive. Such a rating system, in isolation, is not consistent with current findings showing significant differences in adjustment linked to person-based perceptions of alertness. The combined work, home, and social environments of the individual likely contribute to perceived demand and fit of a schedule. Thus a strength of the current study is its integration of individual differences as predictors of coping and adjustment.

Consistent with prior research (Karasek, 1979; Kolgi, 1991; Heaney et al., 1995; Carver et al., 1989, Terry, 1991), findings show a positive interaction between schedule demand and schedule preference on productivity when demand is low (i.e., better alertness). When demand is high, however, schedule preference does not significantly improve productivity. This underscores the combined value of working a shift schedule that decreases demand and also allows employees to self-select the schedule (Kolgi, 1999). As also expected (Karasek, 1979), working a preferred schedule directly benefits adjustment, independent of perceived alertness. Schedule preference relates positively to composite adjustment, physical adjustment, performance, and productivity indices, suggesting the value of both employee expectations as well as utilizing direct employee input to design alternative scheduling options.

Although shiftworker lifestyle training did not show significant direct or interactive relationships with survey study variables including a subjective measure of safety, separate analyses did show employees made significant, objective improvements in overall safety, including significantly decreased OSHA reportable cases, lost workday cases, total accidents, and total days off. This significant improvement to overall safety underscores the value of obtaining objective group data where possible in addition to subjective self-rated measures. Feedback to training was also highly positive from both employees and management, with many employees asking for more training time.

Some employees who received their schedule preference may have deemed training less necessary than those who did not, while others whose least preferred schedule was chosen might have viewed training as insufficient to overcome schedule challenges and thus less likely to implement change. Schedule preference was understandably not associated with shiftworker lifestyle training attendance. It is possible that subtle yet important direct and interactive relationships operated through training in a way not immediately captured by the current analyses.

There may also be delayed training-related improvements linked to psychological and physical health that occur incrementally over several years. For example, the beneficial effects of physician-approved weight loss and exercise programs may not appear at follow-up, particularly given anecdotally reported lapses and setbacks during the first several months, which can have reverse effects near-term. The desire of some employees to first see meaningful benefit among peers can also delay the onset of positive change.

Mediating Effects

In the predictive, integrative LISREL model, both approach and auxiliary coping function in expected ways as mediators between control and adjustment as well as between support and adjustment at outcome, controlling for baseline adjustment (Holahan & Moos, 1987). From an applied perspective using ANCOVA, however, findings are somewhat surprising. Whereas auxiliary coping tends to follow expected paths as a mediator between predictors and adjustment, approach coping does not relate to adjustment and shows no significant mediating paths. In addition to the significant mediating properties depicted for adaptive coping in the structural equation model, a measure of adaptive coping using ANCOVA does reveal mediating properties in the current study, but not as broadly as that seen with auxiliary coping strategies.

While approach coping shows no mediating properties using ANCOVAs in the current sample, auxiliary coping functions as a positive mediator between schedule demand and adjustment including composite adjustment, psychological adjustment, performance, and safety. Additionally, auxiliary coping mediates separate positive links between shiftwork locus of control and spouse/partner support on adjustment. Adaptive coping, meanwhile, mediates between demand and psychological health and also between demand and safety. One possible explanation is that some employees who might utilize approach coping in times of more manageable stress may recognize some stressors relating to shiftwork as especially uncontrollable and therefore more successfully managed through auxiliary coping.

From a therapeutic perspective, advances in stress-resistance research (Antonovsky, 1987; Holahan & Moos, 1994), are exciting, as adaptive coping strategies can be examined as resources that help individuals manage stressful circumstances and remain healthy under stress (Coyne and Downey, 1991; Kessler, Price, and Wortman, 1985). Shiftwork can be viewed as both a chronic and acute stressor, at times uncontrollably so. This is conceptually and clinically important, as an established link exists between contextual factors such as stressful events and detriments to both psychological and physical health (e.g., Dohrenwend & Dohrenwend, 1981). However, less is known about the relationship between stressful situations and coping, although a better understanding has evolved. Holahan and Moos (1987) found that demands stemming from stressful circumstances have been linked to active coping, and Lazarus and Folkman (1984) posit that situationally stressful demands shape coping responses. Fleishman (1984) supports this view by further arguing that coping responses are more situationally based than person-based.

Yet surprisingly little is known about what coping reactions are most and least common during various stages of stressful transactions (Carver et al., 1993). Folkman and Lazaurs (1985) acknowledge the need for a better understanding of individual differences in the stability and variability of coping. But research has focused on specific coping responses in contrast to response variation. More recently, auxiliary coping (Lehrer, 1996) was suggested as a unique coping strategy to add flexibility in managing stressful events. A strength of the study is its conceptualization of auxiliary coping and the subsequent empirical support found for this coping tool as a unique mediator between demand and adjustment.

Moderating Effects

The present design tests both unique and combined effects of control and support on adjustment. The present findings build on previous research showing the importance of locus of control (Rotter, 1966) more generally and shiftwork locus of control more specifically (Smith et al., 1995; Spector, 1988; Costa, 1989; Akerstedt, 1990), as well as spouse/partner support (Cronkite & Moos, 1984; Holahan & Moos, 1987; Cohen & Syme, 1985; Beermann & Nachreiner, 1995) as person-based and social resource variables important in moderating adjustment.

As predicted, the integrative structural equation model testing direct paths between predictors and adjustment shows significant positive relationships between control and adjustment and between support and adjustment. When testing the mediational integrative structural equation model, whereas control relates to adjustment indirectly only through mediating adaptive coping responses, support links to adjustment partially through mediating adaptive coping and also directly to latent outcomes. A review of the literature shows that this is consistent with existing theory and research.

In contrast to control, social support provides for "interpersonal exchanges of affect, affirmation and aid" (Kahn & Antonucci, 1980). Heller, Swindle, and Dusenbury (1986) contend that social support processes involving socializing and companionship enhance appraisals of self-esteem, which in turn relates to psychological health (Cohen & Syme, 1985). It is therefore expected that support relates directly to adjustment as demonstrated in the current study's integrative model. Prior research also shows that individuals with a supportive family environment are more likely to engage in active coping strategies and to seek emotional support when faced with a stressor (Cronkite and Moos, 1984; Holahan and Moos, 1987), particularly when under high stress levels (Holahan and Moos, 1991). Accordingly, mediating paths are also supported. Thus, the direct and mediating paths found for spouse/partner support in the present study are both theoretically and empirically supported.

Previous research has also shown that an internal control orientation relates to more structured use of time, which in turn relates to better coping with shiftwork (Smith, 1995). This is consistent with findings in the current study. More speculatively, it seems less likely that one's knowledge of an internal orientation would by itself consistently relate positively to adjustment unless some action were taken. It is possible that reflecting on how one is likely to perform during stress has adaptive value, yet without adaptive coping responses, a sense of internality may weaken, as internal orientation seems to exist in part as a mobilizing person-based resource to activate adaptive coping responses.

At an applied level, both control and support positively relate as expected to adjustment across all indices, consistent with the hypothesized direct path model. In terms of mediating pathways — as with schedule demand — both control and support relate positively to adjustment through auxiliary coping but not through approach coping. As with schedule demand, it may be that negative appraisal of a stressor has a biphasic effect where approach coping is initially attempted until an arbitrary appraisal threshold is reached at which time auxiliary coping may relate to better adjustment.

Exploratory Moderators

Exploratory variables including age, years of shiftwork, gender, and ethnicity are examined to explore potentially moderating effects that may buffer stress resistance and adjustment outcomes across shiftworking populations in particular and in the general population. Age is a theoretically and clinically important moderating variable, given the average age of shiftworkers continues to rise, with nearly half of utility industry workers over the age of 45 (Energybiz Magazine, 2004). Monk & Folkard report that increasing age is associated with overall weakening of worker health and concurrent decrease in worker ability to cope with stress, decrements in adaptability, a flattening of circadian rhythms, and a tendency towards more fragile sleep and morningness, in contrast to many requirements of shiftwork. The literature further suggests that there is a certain age in the late 40's or early 50's at which shiftwork becomes increasingly difficult to sustain (Barton, 1995). Moreover, circadian rhythms of older individuals tend to show decreased amplitude (Akerstedt and Torsvall, 1981). Older people tend to sleep fewer consecutive hours and supplement this loss of sleep with naps during the day (Monk, 1989; Rosa et al., 1990; Brugere et al., 1997). Thus, the age of a shiftworker can negatively affect their tolerance to nightshift work (Spelten et al., 1995).

In the present design, however, age neither moderates adjustment at follow-up, nor interacts with years of shiftwork, the latter also showing no significant relationships with adjustment. It is important to note, however, that shiftworkers are a self-selecting and sustaining population, often with hardy attributes (Wedderburn, 1995), more financial stability, and greater levels of job seniority as compared to more junior shiftworkers. Thus, benefits associated with increasing age, as well as years of shiftwork, may buffer negative age-related effects.

Findings showed better adjustment at follow-up for males as compared to females, after controlling for the effects of baseline adjustment. However, other factors may affect these results, including the disproportionate number of women as compared to men facing the highly challenging double burden of primary childcare responsibilities coupled with full time employment. Regarding ethnicity, no significant links to adjustment are found, but only African American and Caucasian populations are included as other ethnicities were not of sufficient sample size to allow meaningful analysis. No interactions are found between gender and ethnicity.

THEORETICAL CONTRIBUTIONS

Auxiliary Coping Integrated in Refined Coping Taxonomy

The results regarding coping strategies broaden and refine our conceptualization of coping processes and target the importance of auxiliary coping (Lehrer, 1996) as a theoretically distinct and empirically important strategy. Building on prior research (e.g., Folkman & Lazarus, 1985; Carver, 1993), the current findings expand the categorization of coping processes beyond simple approach and avoidance (Roth & Cohen, 1986) to include a third domain termed auxiliary coping (Lehrer, 1996). Whereas earlier research tends to isolate approach coping as uniquely associated with better psychological outcomes (Compas, Malcarne, & Fondacaro, 1988; Vitaliano, Maiuro, & Russo, 1987), the present study shows that auxiliary coping can be important in optimizing adjustment during times of stress.

Folkman and Lazarus (1985) suggest that person-based differences may be an important factor in coping effectiveness with both short and long-term adaptation outcomes in stress encounters, and Carver and Scheier (1994) argued that stressful encounters can differ considerably in nature from one stage to another. This would seem to apply in part to schedule demand as schedule variation across time creates unique and changing challenges in managing alertness and well-being. Auxiliary coping may therefore be optimally utilized during identifiable stages and/or transition points within the context of a sustained yet variable stressor over time. Miller (1994) reasoned that persons who can vary their choice of coping should show better adaptation than individuals who rely on a more restricted or rigid coping response set. Thus, somewhat speculatively, one's ability to transition between the adaptive coping categories of approach and auxiliary coping would be expected to show better positive benefits to adjustment.

Based on the potential benefits of integrating approach and auxiliary coping strategies into shiftworker lifestyle training, especially given the adaptive use of auxiliary coping strategies supported in the current study, a mnemonic suggests itself to present Carver's (1989) coping strategies parsed according to approach, auxiliary, and avoidance strategies as proposed in the present study. Figure 28 (see Appendix C) presents the mnemonic as a potential learning aid to help shiftworkers and others consider various coping options.

The clinical implications of refining our understanding of coping responses are exciting. Maladaptive response patterns may be attenuated through a better understanding of the nature of coping. For example, discussing with shiftworkers the potential value of periodically applying auxiliary coping strategies may be of use. Interventions targeting individuals' unique coping profiles may enhance optimal adaptation to stress, particularly shiftwork stress.

Spouse/Partner Support Integrated in Expanded Demand-Control-Support Model

The study's findings regarding the relationships between demand, control, and support as predictors of adjustment and mediating coping strategies support a broadened and more refined revision of Karasek's (1979) original demand-control conceptualization of stress and strain processes. Results also further refine the more recently expanded demand-control-job support conceptualization (Johnson, 1989; Karasek & Theorell, 1990).

From a theoretical perspective, Karasek's (1979) original framework and subsequent revisions neglect individual differences concerning both susceptibility to strain and the ability to cope when under strain (Kristensen, 1995). Holahan and Moos (1991) showed that the robustness of predictive associations in a general model of coping varied according to moderating contextual factors. Consistent with previous research highlighted earlier (e.g., see Smith & Folkard, 1993; Dalbokova, 1995; Rotter, 1966; Smith, 1995; Spector, 1988; Costa, 1989, 1995; Holahan & Moos, 1987; Beerman & Nachreiner, 1995), all three indices play a significant and meaningful role among present sample shiftworkers in predicting positive associations with adjustment at outcome in the integrative structural equation models, even after controlling for adjustment at baseline

(Holahan & Moos, 1987). Moreover, the proposed three-predictor multiple regression of adjustment on demand, control, and support accounted for more variation in adjustment at follow-up than did the regression of adjustment on demand and control without including support. These findings support the expanded conceptualization.

From an applied perspective, control and support significantly interact across several adjustment dimensions in the present study (i.e., composite adjustment, psychological adjustment, physical adjustment, specific cardiovascular and digestive symptomatology, and comparatively perceived productivity at follow-up as compared to baseline), with fewer spouse/partner support problems positively relating to adjustment indices at outcome for both low and high internal control subgroups. As well, high internality broadly relates to better outcomes at each level of spouse partner support. In the context of major reported spouse/partner problems, the buffering effect of high internal control on adjustment at outcome is even greater, relating to significantly better adjustment as compared to the low internal control subgroup. These relationships provide further evidence for the refined model.

Applying previous insights framing workplace stress as an effect of both job-related stress and to some extent an interaction between off-job and on-the-job stress, (Beermann and Nachreiner, 1995), a measure of domestic support seems likely to relate to shiftwork stress, as a spouse's or partner's approach to organizing time and activities can be highly important given the substantial effect a shiftworker's schedule can have on one's home life. Interestingly, Thurman (1990) and Kolgi (1991) each noted potentially detrimental effects of negative support. Similarly, Brown et al. (1986) and Finch et al. (1989) acknowledged possible negative changes in adjustment after being "let down" by others. In the current study, greater levels of control coupled with fewer perceived spouse/partner support problems related positively not only to better psychological well-being, but also to increased cardiovascular and digestive health and perceived improvements to productivity at outcome as compared to baseline. Thus the study has practical utility from both a health and performance perspective, underscoring the importance of optimizing employee control and spouse/partner support.

It is important to note some conceptual distinctions in the expanded demand-control-support model. Karasek's (1979) original conceptualization relating psychosocial work environments, stress, and health outcomes viewed job demand as a function of mental work load and arousal demands. This is not inconsistent with the measure of schedule demand used in the current study, although the current conceptualization does relate specifically to environmental alertness as opposed to task-specific demands. Also, whereas Karasek (1979) examines control over job duties in the original conceptualization, the current study examines shiftwork locus of control orientation based on conceptual grounds. Another distinction as compared to the original Karasek (1979) formulation is the perspective that the poorest levels of psychological well-being and the greatest levels of symptoms and ill health exist in high strain environments, understood to be high demand/low decision latitude positions, whereas passive jobs are operationalized as low demand/low decision (see Figure 1, page 74). In the current model, however, "low demand" represents a better schedule from the perspective of employee-perceived alertness, and thus approaches "optimal" demand as the schedule improves further in terms of increased alertness.

PRACTICAL APPLICATIONS

This study has direct applications to shiftwork at both the organization and employee levels. The study's theoretical underpinnings and empirical results can be applied to promote employee alertness and psychosocial health as well as organizational safety and performance. Managing shiftwork stress is a shared responsibility among employees, management, researchers, industry associations, labor organizations, government agencies, and even the general public.

Organization-Focused: Managing Wellness, Operational Performance, and Culture

Both plant and corporate level management increasingly understand that optimized human alertness, performance and health create competitive edge in a global economy. Accordingly, there is much they can do to assist employees and the organization at large address these timely issues. Probably the single best thing companies can do for their employees is to adopt an effective culture (Helmreich & Davies, 2004; Reid, Roberts, & Dawson, 1997) open to change and input from employees, supervisors, and line level managers.

In terms of change management process interventions, both scheduling optimization and fully implemented training initiatives have consistently produced measurable improvements in both employee well-being and performance over many years, yet there are many other options available depending on resources and current scope of interest. Something as simple as a suggestion box, as antiquated as it sounds, has yielded meaningful improvements in schedule management and related environmental accommodations (e.g., better ideas for call-in policies to protect time off, or painting a drab gray wall in a southwestern motif to stimulate overnight alertness are two potential examples of what can be achieved with some forethought and a bucket of paint).

Sleep apnea screening programs have also enjoyed success, as overnight screening is relatively trouble free and non invasive, and prognosis for those diagnosed with apnea does not typically involve surgery; rather, many respond well to a continuous positive air pressure system that shiftworkers and others anecdotally say changes their life for the better. As many employees remain unaware of potential apnea, screening can be a proactive and successful way to protect a company’s long-term investment in its employees by potentially attenuating the development of other related health issues that may be due in part to untreated apnea. Quality sleep centers are now available throughout much of the country and can likely be identified through the employee's primary care physician or other qualified expert.

In terms of performance, there are measurable benefits to managing alertness and fatigue. For example, predictable increases in fuel utilization have been interpolated as a function of induced sleep deprivation among locomotive engineers tested using freight train simulators (DOT, FRA, 1998). From a health and wellness perspective, there are both near and long-term benefits to proactively managing shiftwork stress, as detriments in alertness relating to shiftwork have been shown to relate to depression and anxiety (Silverio, 1997) as well as related medical treatment with psychotropic drugs (Costa, 1993). Thus both employee wellness as well as insurance-related costs can be simultaneously managed by improving schedule-related alertness over time. Furthermore, shiftworkers are more likely to experience anger and irritability as compared to day workers (Frese and Semmer, 1986), and efforts to mitigate these responses in a proactive and supportive way may prevent both long-term health effects relating to irritability as well as potential conflict at home or work.

Efforts to mitigate objective safety incident and severity rates obviously have value, but the methodology needs to follow the concept of openness and collaboration as noted above. Anecdotally, a large Fortune 500 corporation with a vested interest in rapidly improving safety had at one time reportedly implemented a "three strikes and your out" rule in which employees were terminated following any third reported safety incident. Although reported safety incidents rapidly declined, appearing quite good in comparison to last year's data, in reality safety had not changed significantly because root causes had not yet been satisfactorily evaluated and addressed. Subsequently the policy was removed and a more open culture then examined and corrected a number of safety concerns leading to meaningful and important improvements. Although incentives can at times help employees, experience suggests that one can not discipline away impaired alertness, and mangers increasingly understand this.

At the same time, a stellar safety record is no guarantee of future success, nor is it a justification for complacency. In fact, colleagues in senior positions at some of the top safety programs in the country have repeatedly spoken out concerning their search to uncover additional validated improvements to safety, including efforts at mitigating fatigue and shiftwork stress. Interestingly, based on the results of the current study linking schedule preference with improved alertness, it seems likely that proactive efforts to transfer ownership of the shift schedule in part to employees through a data-driven, safety-based process has potential to further improve long-term safety.

Another way that companies large and small can improve their employees' health, safety, and performance is to share information. Scientific and industry-specific journals, conferences, task teams, and trade associations all serve as excellent resources to collect, share, and assimilate potentially useful information. Perhaps most importantly, consistent periodic communication with one's analogous counterpart in both similar and dissimilar operations to discuss lessons learned and ongoing change processes regarding fatigue management initiatives can all inform efforts at learning and applying practical solutions, preferably with pre and post implementation data collected to report back to the stress and coping and shiftwork communities at large for further analyses and integration into the collective literatures and databases.

Employee-Focused: Managing Health, Job Performance, and Family/Social Life

From a practical standpoint, employees can generally benefit by implementing a shiftwork-specific wellness plan coordinated through their primary care physician for health and related issues and through additional specialists as required. A sample of interventions, customized to one's specific 24/7 shiftworker lifestyle, can include gradual changes and introductions to: coping and stress management strategies, 24/7 nutrition, drug abuse education and awareness (e.g., caffeine, tobacco, alcohol, sleeping pills, amphetamines, etc), exercise, family and/or individual counseling, progressive relaxation, sleep management, napping strategies, shift changeover recovery strategies, communications strategies, on-the-job safety, driver safety, alertness management, sleep apnea screening, fatigue management, performance optimization, childcare planning, financial planning, time management training, and job counseling.

Anecdotally, when implementing a subset of such strategies, it is unusual to see health improvements without corresponding improvements in performance and morale. Because many benefits of successfully adapting to a shiftwork lifestyle also potentially benefit an employer, many employees find it comforting to know that the organization typically does not realize related financial gains until the employee in fact feels better, is healthier, and ultimately performs better. Among U.S. companies and abroad, there also seems to be a growing collaborative effort in many instances where employees recognize job security and stability as being directly tied in to corporate profitability, and thus improved job performance is a welcome benefit.

Still, many morale and seniority issues relative to shiftwork remain and likely relate to adjustment over time. To the extent that these issues can be fairly raised and addressed, shiftworker health and performance stands to improve. For example, a freight rail operation approximately a decade ago responded as part of a larger initiative to employee health and safety concerns and working with employees created a napping room to eliminate the reality of locomotive engineers and conductors waiting hours for late trains to arrive only to then depart in an fatigued state with a mile of freight train under their direct control. Experience suggests that management is typically more responsive to such concerns when addressed in a practical and fair manner, as in the case of the railroad, where alertness increased and morale improved with a highly cost-effective fatigue countermeasure.

Similarly, employees can apply such thinking to their own environment at home, creating a climate conducive to recuperative sleep in terms of both quality and quantity, addressing relevant issues such as lighting, temperature, vibration, sound, and aroma. Family/social issues can also be regularly addressed. For instance, many shiftworkers find it useful to distinguish between recovery days following a series of night shifts, and quality days with family after first having a day to recover. Such advanced planning can successfully preempt points of contention among well-intended and supportive family and friends.

By drawing on each others' expertise, shiftworking employees young and older have much to contribute and learn about how to best manage their challenging lifestyles, particularly when they include their spouses and partners. Activities ranging from carpool discussions to bowling leagues to outings among shiftworkers sharing similar work schedules can all help promote biopsychosocial adjustment. Often many available solutions to the challenges of working shifts can be collectively shared among employees and their families (Shapiro et al., 1997).

STUDY LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

Future research in this area could be strengthened in several ways to enhance theoretical knowledge and improve the efficacy of applied interventions. Addressing methodological challenges should further strengthen validity and efficacy, while building on the broadened and refined theoretical foundation may allow for new conceptualizations and interventions.

From a methodological perspective, the nature of the sample, not surprisingly, presents challenges with respect to external validity for the general population. At the same time, a core goal of the study is to examine theoretical and practical issues relating to shiftwork stress resistance, so a balance between sample specificity and overall generalizability creates a need to compromise. Whereas broad theoretical contributions are interesting, the study focused largely on understanding how to best help shiftworkers improve stress resistance. shiftworkers are essentially a self-selected, self-sustaining survivor population not readily subject to the types of strict experimental control one would typically aspire to in a standard Boulder scientist/practitioner training model. For example, the current study did not attempt to randomly select and hold captive half of the sample on the older schedule while formulating an improved one for the sample as a whole and then only testing it on the other half, in essence denying half the sample the benefits of potentially improved alertness throughout the course of a year. As interested in research as most good companies are, that is an understandably untenable scenario. Nor was there experimental control as to who self-selected into the preferred schedule subgroup based on the employee selection process; rather, those who preferred the schedule remained grouped together for portions of the analyses.

More specifically, those individuals preferring a certain type of schedule a priori may in fact be predisposed in ways relevant to the study but not under experimental control. As well, regarding self-selection in general, as previously highlighted, Wedderburn (1995) noted that shiftworkers tend to be more hardy, and thus may perform differently under shiftwork stress than nonshiftworking employees. Hence there exists a practical chicken/egg challenge in discerning whether shiftwork produced the hardiness or hardiness produced the shiftworker.

Educational levels are also dissimilar to the general population, although this is changing across shiftworking operations overall given the evolving scope of "shiftwork" to include computer technicians and other high-tech experts available 24/7. Ethnicity is not well-represented here, confined primarily to African American and Caucasian participants based on company employee demographics, whereas Hispanic, Asian, Caribbean, and Native American populations, for example, were all underrepresented in the present study sample, as were the many other vibrant and important ethnicities that contribute to the national and international fabric of our society. Thus a quasi-experimental design emerges with associated challenges to interpretation. While there are likely useful lessons to be gleaned from the study with respect to stress management practices for the general population, the results must be interpreted in their proper context.

Conversely, the shiftwork population is the specific target of interest, and thus the study benefits considerably from the utilization of shiftworkers as opposed to university freshmen, as one example, as both groups have typically different lifestyles, responsibilities, and stressors, each significant in their own right but not necessarily yielding findings amenable to generalization. As well, even potentially confounded differences in adjustment relating to issues such as gender, potentially influenced by the disproportionate number of females faced with a "double burden" of both work and primary child care responsibilities, represent real world perspectives for many women struggling to support their families with or without a spouse/partner at home to help.

Thus, issues of female double burden, shiftworker-specific characteristics, higher divorce rates among shiftworkers, and several other factors, while contributing to increased challenges for generalizations beyond shiftworking populations, simultaneously increase external validity when confined strictly to shiftworking populations at-large. But even here, potential confounds relating to geographic proximity, industry specificity, job specificity, and other unique sample attributes present cause to reflect before generalizing too readily or broadly. Fortunately, shiftworkers as a group tend to be more similar than dissimilar and thus likely readily accommodate generalization more easily than the general population, although the precautionary concerns remain valid.

Regarding study measures themselves, several issues emerge that deserve mention. First, there is another chicken/egg concern regarding order effects. Does training affect support or does support affect training? Or both? And what about demand and control? Because the study was approached as a predictive relational inquiry as opposed to a directly causative study, some of these concerns may not be as applicable here, but they are certainly worth considering as they still can affect paths of association and are potentially items of considerable informed debate.

In terms of measurement methodology, many indices are self-report by design, although efforts were made to gather both relatively objective (e.g., medical diagnoses) and subjective (e.g., spouse/partner support) measures. Where possible multiple measures were obtained, such as the measures of safety including both objective OSHA-related company reported data as well as employee-reported indices.

With respect to the shiftworker lifestyle training initiative, it is important to note that due to the scope and costs of administering the large-scale study, with over 2000 employees eligible for training (52.4% of the study sample voluntarily attended), a corporate decision was made to limit the regularly scheduled four-hour sessions to two-hours, which were further condensed due to anticipated shift changeover delays and other administrative details involving rapid assembly and disassembly of consecutive audiences, including additional time allotted for company-sponsored raffles during each session, in and of themselves a potential confound as some may have been primarily interested in winning an automobile. As well, audiences were at times significantly larger than desired and thus precluded greater levels of individual focus. Accordingly, several sections were condensed and/or dropped, with an understandable focus on alertness, safety and performance, with some albeit less available time for critically important areas such as stress management, family and social life, and shiftworker nutrition.

Moreover, it is also possible that those experiencing less schedule demand felt less need to attend and/or implement training. On the other hand, those experiencing the greatest levels of schedule demand due to person-based differences in responding to the original schedule may have been less capable of implementing proactive training countermeasures under higher stress levels. Much as a baby best learns to take a bottle not when it's truly hungry but rather in a relaxed state and able to apply both operant and classical conditioning principles, so a shiftworker may have an optimal state of training receptivity relative to recent levels of perceived and/or actual stressors. This is a question that future analyses may be able to tease apart by more fully considering the context within which training sessions are conducted, including both current stress and alertness levels.

As well, there may be somewhat hidden time delayed benefits that are remain dormant until after follow-up measures and manifest themselves incrementally over several years. For example, the beneficial effects of weight loss and exercise initiatives coordinated through the employee's medical doctor as a result of training may not readily appear in subsequent data at follow-up, particularly given anecdotally reported lapses and temporary setbacks during the first several months of such initiatives.

Concerning spouse/partner support, a measure of attendance during shiftworker lifestyle training was also obtained but upon further reflection was eliminated from the study as anecdotally many employees indicated their spouse/partner wanted to attend but was unable to do so given preexisting childcare and/or work responsibilities, which raises the additional question of how to best optimize shiftworker and spouse/partner attendance across training sessions in the future. As well, based on the importance of spouse/partner support both theoretically and empirically as a predictor of adjustment outcomes in the present study, future studies would benefit by more fully integrating spouse/partner support data in subsequent analyses.

Communication efforts are usually helpful here, but new suggestions will hopefully further increase attendance without negatively influencing affectivity during the training. Anecdotally, and also based on thousands of feedback forms, response to training from both employees and their spouses/partners in its full four hour context when delivered with empathy, energy, and passion is typically excellent, but attendance rates of a little over 50% seem to be the norm. Despite that, some companies manage to have 90-100% of their employees appear and benefit, while others provide benefit to only 25% of their eligible workforce. New strategies to optimize attendance amidst multiple other demands are encouraged and essential in providing additional coping strategies.

Communication also typically assists with problems of respondent veracity, and considerable efforts were taken before, during, and after the surveys to assure optimal veracity within the limits of such an initiative. As with other studies, however, veracity is always a concern and must be considered (see Subject Validity Criteria, Appendix A). Regarding efforts before and during the initial survey, both pre-survey informal meetings and consistent proctoring throughout all nine consecutive shifts over a three-day period rendered what is hopefully relatively robust data, which was then subject to additional veracity criteria as referenced above.

With regard to the subject validity criteria, some respondents did anecdotally report that they had "fun" with those particular items yet responded truthfully to all others. Unfortunately their responses would have been eliminated from the analyses once validity criteria returned below the threshold for inclusion in the study. Given today's more sophisticated survey consumer in general, transparency is more likely as compared to when the measure was first established. This points to the utility in new and/or revised validity measures to further strengthen the practical utility and interpretation of such studies.

Another challenge to veracity understandably emerges for at least some individuals. Despite considerable efforts to present all schedules in their realistic operating state based on the unique company job requirements and culture for handling days off, etc, and even after spending considerable time explaining what is typically a cost-neutral change in pay, there is usually a small yet highly vocal sub sample of employees initially convinced of alternative motives to either reduce headcount or otherwise cut payroll, which is not at all the intent of a properly executed schedule change initiative presented with integrity and candor across all parties throughout.

The return to the company comes instead in terms of reduced accidents and injuries as well as increased productivity, improved morale, and a host of other likely benefits if properly executed to truly afford employee-driven preferences in the context of operational management boundary conditions (e.g., 24/7 operation in most cases). Still, pay invariably emerges as an important issue and for some unfortunately leaves them with a less than desired schedule, which then slightly skews results as they would have in effect received their "preferred" schedule but not in fact their "optimal" schedule. Fortunately, given additional time spent on site before administering the survey, rapport over time typically addresses this challenge.

In addition to frank veracity, challenges with memory recall may have also adversely affected respondent accuracy, particularly given the reported deleterious effects of the original schedule for many at the time of baseline measures. Considerable fatigue among at least some respondents while taking the survey is a reasonable concern as mentioned earlier, but again representative of what much of the shiftwork population faces on a regular basis.

Upon follow-up, however, a methodological concern emerged, in part due to considerably favorable corporate, site, and employee feedback concerning the results thus far through both informal and formal company metrics and employee self-report (e.g., reductions in safety-related incidences while sustaining productivity goals, and self-reports of improved family/social life). Given the anticipated positive results, management opted not to pay the considerable overtime costs involved in assembling close to 2000 employees for the follow-up survey (over 1700 employees took the survey at baseline over the three day, nine session period). Accordingly, employees took the survey home to fill out but did have to confirm their anonymous study-generated ID number to turn in the score sheet. Even so, ideally all respondents would have additionally taken the survey on site at follow-up as they had done at baseline.

It is also important to consider additional covariates not specifically analyzed in the current design. For example, although overtime and absenteeism were not generally unusual or excessive in the sample, in other samples it can be and thus should be considered when making interpretations regarding schedule redesign, as the differences in demand between a paper schedule and real world operations with overtime can be vastly different and affected by multiple variables including double shifts, call-ins, outages, emergency maintenance, unanticipated production increases, staffing shortages, weather related holdovers and emergencies, vacation coverage, and other both anticipated and unanticipated events.

The power of the statistical tests themselves was a concern for some of the analyses. Although it was certainly true that some statistically significant findings emerged with relatively low power, more often than not the reverse was true, where the potential for a type II error increases with lower power. Thus, there may have been findings of significance that were overlooked in the present design, even given the sizable gross sample of 603 after subject validity criteria were imposed. Despite the challenges regarding power, effect size analyses tended to more accurately portray actual effects, if any, and it is likely that these differences of theoretical and practical utility were not largely overlooked solely due to considerations of power.

Regarding timing of the collected variables utilized in the current study's analyses, whereas schedule demand was operationalized as a comparative measure of alertness assessed at time 2 in relative comparison to time 1 alertness before implantation of schedule changes, it was not assessed at time 1. As well, although both spouse/partner support and shiftworker locus of control were each assessed at time 1, allowing for true prospective analyses by testing, for example, time 1 control on time 2 adjustment covarying for time 1 adjustment, a decision was made to instead utilize time 2 control and support in part because demand was captured at time 2 and also partly due to the very nature of the scheduling optimization process, which was already underway by the time of the baseline survey.

Speculatively, many employees at time 1 survey appear especially receptive toward change. After employees have had an opportunity to experience any new schedule change for close to a year, one may find more conservative self-report. Alternatively, some employees may be overly pessimistic at time 1 due increased awareness of the challenges of the current schedule. Finally, those employees not able to work their preferred schedule may initially feel resentment towards the process and hope to show others how poor the new schedule is.

Anecdotally, this is a repeatable, manageable process across industry and geograph; over time the contrarian individual(s) typically conclude that the new schedule is not as bad as they thought and in many cases much better, and some become the most enthusiastic supporters of the process overall. This transition tends to be a delicate consultative process managed to successful conclusion with care and empathy for the employee's concerns.

Also, it is always possible that some or all of the positive results such as broad-based improvements to adjustment and several associated indices, may be temporary. Although attempts were made to control extraneous factors, Hawthorne effects (Mayo, 1933) can not be ruled out. However, the 24-month follow-up period over which objective OSHA-related safety data was measured does suggest Hawthorne alone is unlikely to account for all persistent study variable change. Other limitations including history may have also influenced results. Thus the study would be further strengthened by periodic assessment of related stress resistance and adjustment characteristics at appropriate intervals to examine the persistence of variable parameter changes over time.

Another important consideration when interpreting findings is any underlying bias in the study's sample of 603 shiftworkers; that is, what characteristics of the study sample that successfully satisfied subject validity criteria (Appendix C) differ in meaningful ways from the shiftwork population in general. Further, what additional bias led some sample subjects to participate in certain aspects of the study, such as training, while other subjects did not? Although the study examines outcome differences based on training participation, more research is needed to explore meaningful differences in subjects that attend versus neglect training opportunities. Such considerations may enhance both external validity and training attendance, especially for those who may benefit most.

At the biological level, it would be informative to explore in a noninvasive way how higher levels of demand "switch on" coping strategies in certain individuals as compared to others, and how coping strategies may in turn switch on demand appraisals, and vice versa. Additionally, one could examine more fully different mechanisms and paths for activating such strategies, utilizing functional MRI and controlled stressor scenarios to study differential areas of activation for both differentiated levels of stressors and across different individuals as well as over time to further test person-based and time based differences in activating responses. Results may inform stress and coping processes in unexpected ways.

The creation of biopsychosocial work environments is another technology-based innovation that integrates design features into the workplace to help sustain alertness. Instead of fitting the shiftworkers into the room, the room is designed to fit the shiftworkers' unique 24/7 needs. Efforts are underway in a number of related areas, and their integration will be considerably helpful to shiftworkers struggling to stay awake and vigilant during their shift.

Comprehensive biopsychosocial environments will, in response to real-time laser tracking measurements of employee eye blink rate compared to baseline (one of numerous possible solutions for assessing diminished alertness to criteria without distracting the employee), set in motion a series of coordinated changes such that a control room operator, if paying enough attention, will notice light dimmers slowing brightening, orange and red pastels gradually appearing on a pale canvas, peppermint slowly wafting from the HVAC system at a randomized parts per billion distribution rate to mitigate habituation, slight vibrations coming from underneath the employee's chair, temperature slightly decreasing with music beating in time, increasing volume just shy of a noticeable difference until habituation occurs and volume increases shy again of another just noticeable difference. All done simultaneously, all done seamlessly, and all working for the employee to sustain 24/7 alertness.

The industrialized control room will likely soon resemble this scenario, as will other 24/7 operating environments. No big brother this – the goal will instead be solely to "keep the employee awake and the plant safe." One point of clarification remains, however. Instead of an employee noticing, as indicated earlier, these subtle changes if paying attention, it is rather more accurate to say that the employee will not notice these changes if not paying attention.

Regarding measurement of alertness, several studies have used EEG encephalography as opposed to survey self-report. While EEG has unique challenges concerning measurement veracity, it is still likely far more accurate than Likert-type retrospective assessment of perceived alertness, which by its very nature is subject to memory recall challenges and state-related subject bias among other potential confounds. Yet from a practical standpoint, survey measurement is far more readily accessible and often the instrument of choice among several options. It does, however, point to the importance of asking the right questions.

CONCLUSIONS

Were we designed to rock around the clock, or were Bill Haley and His Comets (Myers, 1953) neglecting the beat of mother nature's curfew? Unlike programmable rhythm machines available full throttle 24/7 – from tango to techno at the flip of a switch – we humans find it harder to skip a beat. Yet, in alarming numbers some of us must work irregular hours, and many others choose to do so. Industrial shiftworkers, pilots, locomotive engineers, emergency medical personnel, nightshift nurses, researchers, network server technicians, teachers, parents, singles, and even fast food teenage employees all at times face long, irregular hours born in the filaments of Edison's persistence. But are there consequences of bending night into day and stressing the tensile limits of human performance? And if so, what tools exist to help sustain health and performance around-the-clock as the call for shiftworkers echoes beyond the new millennium?

Based on the present findings, there are helpful ways to buffer shiftwork stress resistance and improve shiftworkers' health and performance. More flexible use of auxiliary coping in addition to approach coping styles is important. Schedule demand is better managed through employee input. Feeling in control of shiftwork stress also helps maintain well-being. Moreover, social support is an important enhancing factor. Individual differences matter. Work cultures that promote alertness improve psychosocial health and performance. Work environments built to work alert can protect safety and increase productivity.

As the dissertation is a beginning, it is appropriate to conclude with a question:

Are you alert enough to ________?

Appendix A: Survey Scales

General Health Questionnaire (GHQ)

Survey Items 134-145 (i.e., location of items appearing in actual post-implementation survey)

The following questions deal with **how you have felt in general over the past few weeks.** Remember to concentrate on present and recent complaints, not those that you had in the distant past.

Have you recently: (over the **past few weeks**)	A	B	C	D
1. been able to concentrate on what you are doing?	Better than usual	Same as usual	Less than usual	Much less than usual
2. lost much sleep over worry?	Not at all	No more than usual	Rather more than usual	Much more than usual
3. felt that you are playing a useful part in things?	More so than usual	Same as usual	Less than usual	Much less than usual
4. felt capable of making decisions about things?	More so than usual	Same as usual	Less than usual	Much less than usual
5. felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual
6. felt you could not overcome your difficulties?	Not at all	No more than usual	Rather more than usual	Much more than usual
7. been able to enjoy your normal day to day activities?	More so than usual	Same as usual	Less than usual	Much less than usual
8. been able to face up to your problems?	More so than usual	Same as usual	Less than usual	Much less than usual
9. been feeling unhappy and depressed?	Not at all	No more than usual	Rather more than usual	Much more than usual
10. been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
11. been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
12. been feeling reasonably happy all things considered?	More so than usual	Same as usual	Less than usual	Much less than usual

Physical Health Questionnaire (PHQ)

Cardiovascular (Crd): Survey Items 87-97
Digestive (Dig): Survey Items 79-86

A	B	C	D
Almost never	Quite seldom	Quite often	Almost always

Choose the best answer that indicates how frequently you experience the following:

Crd 1. How often do you suffer from heart palpitations?

Crd 2. How often do you suffer from aches and pains in your chest?

Crd 3. How often do you suffer from dizziness?

Crd 4. How often do you suffer from sudden rushes of blood to your head?

Crd 5. Do you suffer from shortness of breath when climbing the stairs normally?

Crd 6. How often have you been told that you have high blood pressure?

Crd 7. Have you ever been aware of your heart beating irregularly?

Crd 8. Do you suffer from swollen feet?

Crd 9. How often do you feel “tight” in your chest?

Crd 10. Do you feel you have put on too much weight since beginning shiftwork?

Crd 11. Do you feel you have lost too much weight since beginning shiftwork?

Dig 1. How often is your appetite disturbed?

Dig 2. How often do you have to watch what you eat to avoid stomach upsets?

Dig 3. How often do you feel nauseous?

Dig 4. How often do you suffer from heartburn or stomach-ache?

Dig 5. How often do you complain of digestion difficulties?

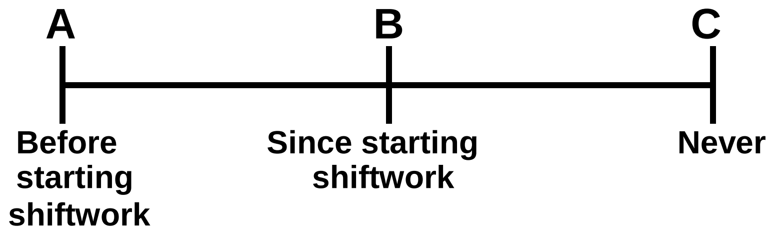
Dig 6. How often do you suffer from bloated stomach or flatulence?

Dig 7. How often do you suffer from pain in your abdomen?

Dig 8. How often do you suffer from constipation or diarrhea?

Medical Diagnosis, Standard Shiftwork Index

Survey Items 98-120

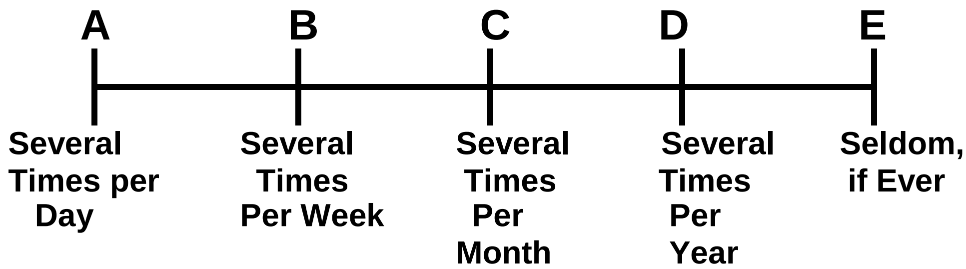


Have you suffered from any of the following **(<u>DIAGNOSED BY YOUR DOCTOR</u>)?**

1. Chronic back pain
2. Gastritis, duodenitis
3. Gastric or duodenal ulcer
4. Gall stones
5. Colitis
6. Sinusitis, tonsillitis
7. Bronchial asthma
8. Angina
9. Severe heart attack (myocardial infarction)
10. High blood pressure
11. Cardiac arrhythmias
12. High cholesterol
13. Diabetes
14. Cystitis
15. Kidney stones
16. Eczema
17. Chronic anxiety
18. Depression
19. Arthritis
20. Hemorrhoids
21. Varicose veins
22. Anemia
23. Headaches

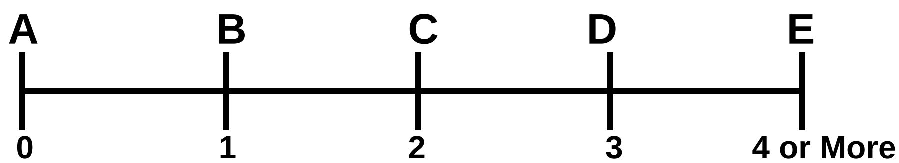
Safety Scale

Survey Items 149-150, 155, 157



1. How often do you briefly nod-off or fall asleep **while <u>working</u>** your **current schedule**?

2. How often do you briefly nod-off, or fall asleep **while <u>driving</u>** to and from work on your **current schedule**?



3. How many **automobile <u>near</u> accidents** did you have in the past **four months**?

4. During the past **four months**, how many **<u>near</u> accidents, errors or injuries** have you had **on the job**?

Productivity Scale

Survey Items 147, 151, 153, 160

A	B	C	D	E
Less than 5 Hours	5 Hours	6 Hours	7 Hours	8 or More Hours

1. How many hours of sleep per 24-hour period are you actually getting, on average, during days that you work?

A	B	C	D	E
Several Times per Day	Several Times Per Week	Several Times Per Month	Several Times Per Year	Seldom, if Ever

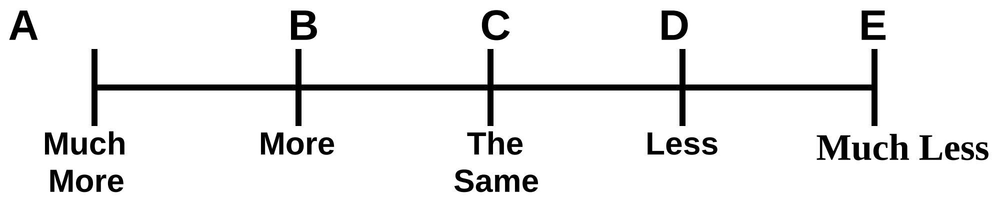
2. How often do you make **mistakes or mental errors** while working on your **current schedule**?

3. How often do you feel **fatigued** while working on your **current schedule**?

4. How would you rate the **quality of sleep** that you are getting when working shifts on your **current schedule**?
   a. Excellent
   b. Good
   c. Average
   d. Somewhat below average
   e. Poor

Comparative Productivity:

Survey Item 51



PLEASE CONTINUE TO ANSWER COMPARING **HOW YOU GENERALLY FEEL NOW** IN THESE AREAS VERSUS BEFORE THE SCHEDULE SELECTION PROCESS BEGAN, EVEN IF YOU ARE STILL ON THE SAME SCHEDULE.

1. Productivity **on the job**?

Brief COPE Scale

Survey Items 173-192, 194-201 (Exploratory Active Acceptance (AA*) subscale also shown).

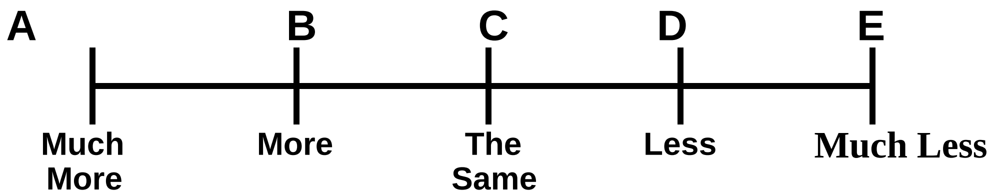
A	B	C	D
I haven't been doing this at all	**I've been doing this a little bit**	**I've been doing this a medium amount**	**I've been doing this a lot**

Everyone has to manage stress in their lives, and there are many ways to try to deal with problems. Each of the following items says something about a particular way of coping. Indicate the extent to which you **currently usually or typically** do each of the things listed when under stress. Don't answer on the basis of whether it seems to be working or not just whether or not you're doing it. Choose the one **BEST** answer for each item on this page, and please make your choice **as true FOR YOU as you can**.

1. I've been turning to work or other activities to take my mind off things.
2. I've been concentrating my efforts on doing something about the situation I'm in.
3. I've been saying to myself "this isn't real."
4. I've been using alcohol or other drugs to make myself feel better.
5. I've been getting emotional support from others.
6. I've been giving up trying to deal with it.
7. I've been taking action to try to make the situation better.
8. I've been refusing to believe that it has happened.
9. I've been saying things to let my unpleasant feelings escape.
10. I've been using alcohol or other drugs to help me get through it.
11. I've been trying to see it in a different light, to make it seem more positive.
12. I've been trying to come up with a strategy about what to do.
13. I've been getting comfort and understanding from someone.
14. I've been giving up the attempt to cope.
15. I've been looking for something good in what is happening.
16. I've been making jokes about it.
17. I've been doing something to think about it less, such as going to movies, watching TV, reading, daydreaming, sleeping, or shopping.
18. I've been accepting the reality of the fact that it has happened.
19. I've been expressing my negative feelings.
20. I've been trying to find comfort in my religion or spiritual beliefs.
21. I've been focusing on something else important if I couldn't solve this problem (AA*).
20. I've been trying to get advice from someone about what to do.
23. I've been putting aside other activities in order to concentrate on this.
24. I've been learning to live with it.
25. I've been thinking hard about what steps to take.
26. I've been praying or meditating.
27. I've been making fun of the situation.
28. I've been talking to someone to find out more about the situation.
29. I've been trying to keep myself from getting distracted by other thoughts or activities.
30. I've been finding another way to be productive during this situation if I couldn't completely solve the problem (AA*).

Schedule Demand Scale

Survey Items 48-50



PLEASE CONTINUE TO ANSWER COMPARING **HOW YOU GENERALLY FEEL NOW** IN THESE AREAS VERSUS BEFORE THE SCHEDULE SELECTION PROCESS BEGAN, EVEN IF YOU ARE STILL ON THE SAME SCHEDULE.

2. Alertness on the job?

3. Alertness driving to/from work?

4. Alertness during time off (not including driving to/from work)?

Shiftwork Locus of Control Scale (SHLOC)

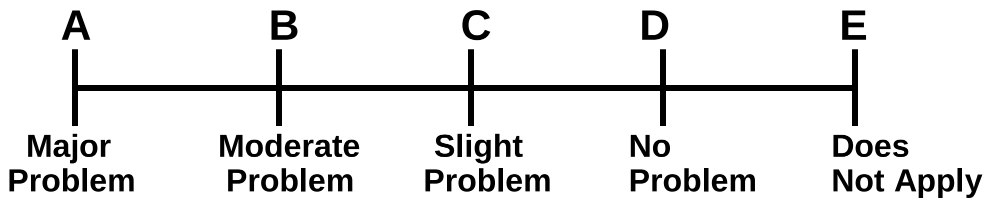
Survey Items 162-169

A	B	C	D	E
Strongly Agree	Agree	No Preference	Disagree	Strongly Disagree

1. I am responsible for how well I sleep when working shifts.
2. My own behavior influences the extent to which my social life is interfered with when on shifts.
3. When working shifts I can influence my performance.
4. I control whether or not my health is harmed when I work shifts.
5. My physical well-being depends on how well I take care of myself when I work shifts.
6. When on shifts I determine whether or not I get good results at work.
7. When on shifts I have control over the quality of sleep I get.
8. I am directly responsible for the quality of my social life when I am working shifts.

Spouse/Partner Social Support

Survey Item 73



Are any of the following **CURRENTLY** a problem for you?

1. Not enough understanding and emotional support from spouse or partner

Eysenck Validity Scale

Survey Items 19,128, 129, 133, 172, 231, 233, 235, 237

Note: Eysenck items were integrated to optimize content validity while mimimizing their face validity. Accordingly, the last four Eysenck items were formatted with a 4-point Likert scale to be consistent with contiguous items and were converted to yes/no responses as indicated below.

1. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so?

   a. Yes
   b. No

2. Have you ever been late for an appointment or work?

   a. Yes
   b. No

3. Once in a while do you lose your temper and get angry?

   a. Yes
   b. No

4. Are all your habits good and desirable ones?

   a. Yes
   b. No

5. Do you sometimes talk about things you know nothing about?

   a. Yes
   b. No

6. Of all the people I know there are some whom I definitely do not like.
   I sometimes gossip.

   a. Yes (agree, strongly agree)
   b. No (disagree, strongly disagree)

7. I sometimes gossip.

   a. Yes (agree, strongly agree)
   b. No (disagree, strongly disagree)

8. I occasionally have thoughts and ideas that I would not want other people to know about.

   a. Yes (agree, strongly agree)
   b. No (disagree, strongly disagree)

9. I would always declare everything at customs even if I knew that I could never be found out.

   a. Yes (agree, strongly agree)
   b. No (disagree, strongly disagree)

Appendix B: Comprehensive Post-Implementation Survey

INTRODUCTION

There are two main purposes for this **confidential** follow-up questionnaire. First, now that some time has passed since the union members were able to vote on a schedule in each of the 8 work areas, we want to determine how successful the shift schedule selection program has been thus far. This will give us an important look at how people feel about their current schedule, as well as how they are able to manage. Secondly, it will provide important data to research areas that affect you such as family and social life, health and well-being, sleep, alertness, safety, and stress management. Taken together, this information will lead to a better understanding of your overall needs so that both your schedule and your skills in managing the challenges of shiftwork can best work together to meet your goals for a satisfying and healthy lifestyle. **There are no right or wrong answers**, only your personal feelings and preferences.

Please mark your computer score sheet with a **#2 pencil** to indicate your **single best answer** for each question. Please answer every question unless specifically asked not to. The last page is for any comments you may wish to make.

Thank you for taking the time to fill out this questionnaire, and please be assured that your information will be **anonymous; that is, no one will be able to identify your individual responses or comments.** We take this extra step because experience has shown that people are more open about their preferences when they know their answers will be anonymous. Thanks again for your effort. It is greatly appreciated and will let us better meet your overall needs and preferences.

SECTION I
CONFIDENTIAL GENERAL INFORMATION

1. What is your **gender**?
   - **a.** Female
   - **b.** Male

2. What is your **age**?
   - **a.** 18 - 24
   - **b.** 25 - 34
   - **c.** 35- 44
   - **d.** 45 - 54
   - **e.** 55 or older

3. What is your **ethnicity**?
   - **a.** African American/ Black
   - **b.** Caucasian/ White
   - **c.** Hispanic/ Latino/ Latina
   - **d.** Asian/ Pacific Islander
   - **e.** other

4. What is your current **marital status**?
   - **a.** Single
   - **b.** Separated/Divorced
   - **c.** Partner
   - **d.** Married
   - **e.** Widowed

5. What is your **educational background**?
   - **a.** Some High School
   - **b.** High School Diploma or G.E.D.
   - **c.** Some college
   - **d.** Four year college degree
   - **e.** Graduate school

6. In which **area** do you primarily work? **(Choose "e" if your area is in question #7).**
   - **a.** SFT
   - **b.** EET
   - **c.** SPT
   - **d.** Fabrication
   - **e.** If none of the above, choose this answer.

7. In which **area** do you primarily work? **(Choose "e" if your area was in question #6).**
   - **a.** Primary
   - **b.** Shipping
   - **c.** Supply
   - **d.** Parts
   - **e.** If none of the above, choose this answer.

8. To which **shift** are you primarily assigned?
   - **a.** **8**-hour Day Shift
   - **b.** **8**-hour Evening Shift
   - **c.** **8**-hour Night Shift
   - **d.** **12**-hour Day Shift
   - **e.** **12**-hour Night Shift

9. How many years have you been **working at B&W**?
   - **a.** Less than 1 year
   - **b.** 1 year or more, but less than 5 years
   - **c.** 5 years or more, but less than 10 years
   - **d.** 10 years or more, but less than 15 years
   - **e.** 15 years or more

10. How many years have you been working **shiftwork**?
   - **a.** Less than 1 year
   - **b.** 1 year or more, but less than 5 years
   - **c.** 5 years or more, but less than 10 years
   - **d.** 10 years or more, but less than 15 years
   - **e.** 15 years or more

11. Does your **spouse or partner work** outside the home?
   - **a.** Yes, full time
   - **b.** Yes, part time
   - **c.** No
   - **d.** Does not apply

12. If you do any additional work (for pay) other than your current job at B&W, please indicate the approximate number of hours per week that you work on your **second job**.
   - **a.** 1-10
   - **b.** 11-20
   - **c.** 21-30
   - **d.** 31 or more
   - **e.** Does not apply

13. On average, about how many hours of **overtime** do you work each week **at B&W**?
   - **a.** less than 10
   - **b.** 10 - 19
   - **c.** 20 -29
   - **d.** 30 - 39
   - **e.** 40 or more

SECTION II
SCHEDULE SELECTION AND RESULTS

Please make sure that the question number on the survey matches the answer number on the score sheet.

14. Did you fill out the original scheduling survey in November?
    a. yes
    b. no

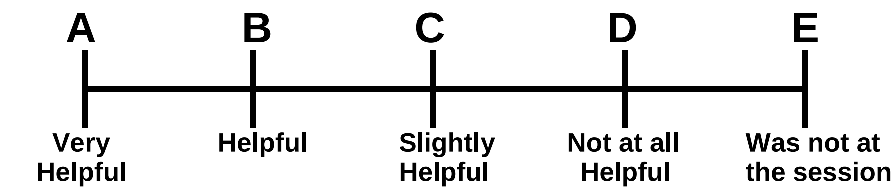
15. What schedule are you **CURRENTLY** working, not including overtime?
    a. 6-2 eights
    b. 2-3-2 twelves
    c. 5-2 twelves
    d. other

16. Did you participate in voting for a schedule in either the first round (where there were many choices) or in the final round (where there were two choices)?
    a. First round and final round
    b. First, not final round
    c. Final, not first round
    d. Did not vote

17. Did you vote in either round **for the schedule that was chosen in your area?**
    a. First round and final round
    b. First, not final round
    c Final, not first round
    d. Voted, but not for the chosen schedule
    e. Did not vote

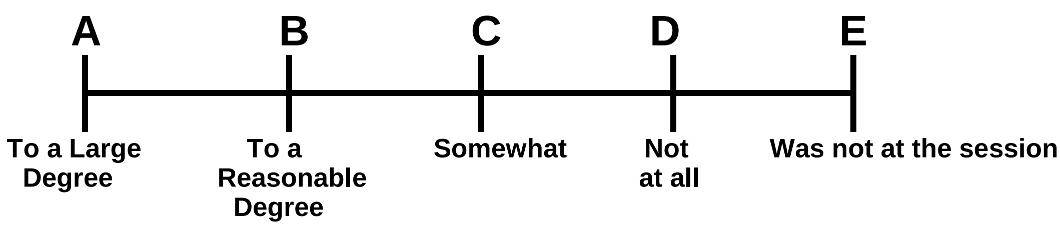
18. Did you attend the training program on Managing a Shiftwork Lifestyle, and did your partner (if this applies) join you?
    a. Yes, attended the entire program with my partner
    b. Yes, attended the entire program by myself (partner not there or don't have one)
    c. Was there for part of the program with my partner
    d. Was there for part of the program by myself (partner not there or don't have one)
    e. No, did not attend

19. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so?
    a. Yes
    b. No



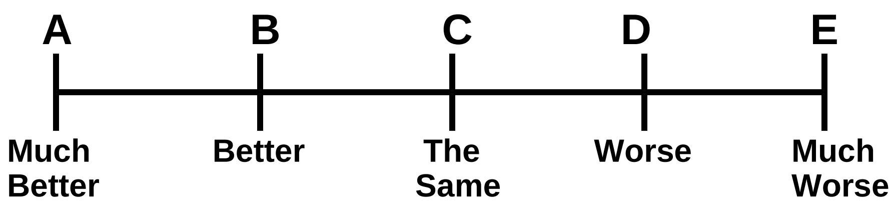
How helpful was each of the following sections from the training program on Managing a Shiftwork Lifestyle? That is, to what extent did they provide you with useful ideas that **could** help you better understand and adjust to the demands of your schedule?

20.	Section I:	Introduction to Circadian Physiology
21.	Section II:	Shiftworker Sleep Management
22.	Section III:	Shiftwork, Alertness, and Performance
23.	Section IV:	Shiftworker Health and Safety
24.	Section V:	Shiftwork and Nutrition
25.	Section VI	Shiftwork Family and Social Issues



To what extent **have you actually put the ideas from the training program into effect** and have actually taken steps to improve your understanding and/or circumstances in the following areas?

26.	Section I:	Introduction to Circadian Physiology
27.	Section II:	Shiftworker Sleep Management
28.	Section III:	Shiftwork, Alertness, and Performance
29.	Section IV:	Shiftworker Health and Safety
30.	Section V:	Shiftwork and Nutrition
31.	Section VI	Shiftwork Family and Social Issues



FOR QUESTIONS 32-57, PLEASE ANSWER COMPARING **HOW YOU GENERALLY ARE NOW** IN THESE AREAS VERSUS BEFORE THE SCHEDULE SELECTION PROCESS BEGAN, EVEN IF YOU ARE STILL ON THE SAME SCHEDULE.

32. Physical health

33. Mental health

34. Family life

35. Social life

36. Working life

37. Coping with stress on the job with your **supervisor**

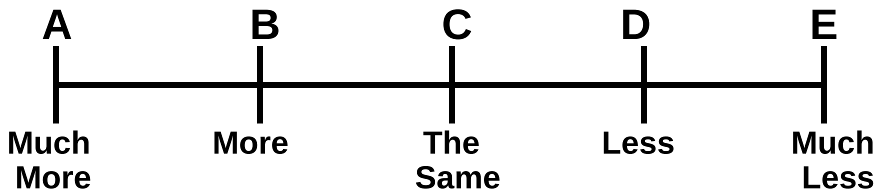
38. Coping with stress on the job with **other employees**

39. Coping with stress **driving to/from work**? **LEAVE BLANK IF THIS DOES NOT APPLY, AND SKIP A LINE ON YOUR ANSWER SHEET**

40. Coping with stress with your **spouse or partner. LEAVE BLANK IF THIS DOES NOT APPLY, AND SKIP A LINE ON YOUR ANSWER SHEET**

41. Coping with stress with **other immediate family members**. **PLEASE CHECK THAT YOU MARK #41 ON THE ANSWER SHEET**

42. Coping with stress with your **friends**



PLEASE CONTINUE TO ANSWER COMPARING **HOW YOU GENERALLY FEEL NOW** IN THESE AREAS VERSUS BEFORE THE SCHEDULE SELECTION PROCESS BEGAN, EVEN IF YOU ARE STILL ON THE SAME SCHEDULE.

43. Support from **spouse/partner**. **LEAVE BLANK IF THIS DOES NOT APPLY, AND SKIP A LINE ON YOUR ANSWER SHEET**

44. Support from **other immediate family members PLEASE CHECK THAT YOU MARK #44 ON THE ANSWER SHEET**

45. Support from **friends**

46. Support from your **supervisor**

47. Support from **other employees**

48. Alertness **on the job**

49. Alertness **driving to/from work**? **LEAVE BLANK IF THIS DOES NOT APPLY, AND SKIP A LINE ON YOUR ANSWER SHEET**

50. Alertness during **time off** (not including driving to/from work)? **PLEASE CHECK THAT YOU MARK #50 ON THE ANSWER SHEET**

51. Productivity **on the job**?

52. Energy level during **time off**?

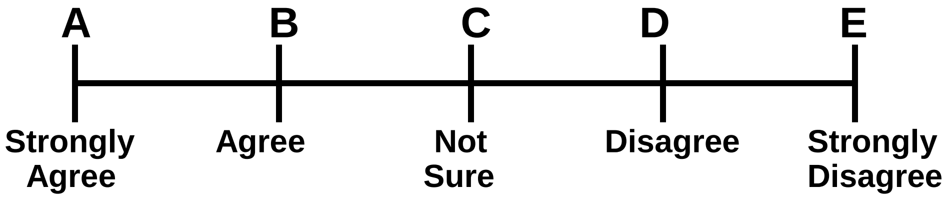
53. Control in **managing your job**?

54. Control in managing your **home life** with your **spouse or partner**? **LEAVE BLANK IF THIS DOES NOT APPLY, AND SKIP A LINE ON YOUR ANSWER SHEET**

55. Control in managing your **home life** with **other immediate family members**? **PLEASE CHECK THAT YOU MARK #55 ON THE ANSWER SHEET**

56. Control in managing your **social life**?

57. Time to get things done?



58. I feel that the schedule selection process was a fair one.

59. Overall, I feel that the schedule selection process gave me more control of my life.

60. Given that the plant operates 24 hours a day, I prefer working my **current schedule** as compared to when I was working the 6-2 before the schedule selection process (please answer even if you are still working the same schedule).

SECTION III

FAMILY AND SOCIAL LIFE

A	B	C	D	E
Major Problem	Moderate Problem	Slight Problem	No Problem	Does Not Apply

Are any of the following **CURRENTLY** a problem for you?

61. Not enough "quality" time with spouse or partner
62. Not enough "quality" time with other close family members
63. Not enough "quality" time with friends
64. Feeling isolated and apart from spouse or partner
65. Feeling isolated and apart from other close family members
66. Feeling isolated and apart from friends
67. Feeling grouchy or irritable around spouse or partner
68. Feeling grouchy or irritable around other close family members
69. Feeling grouchy or irritable around friends
70. Communicating with spouse or partner
71. Communicating with other close family members
72. Communicating with friends
73. Not enough understanding and emotional support from spouse or partner
74. Not enough understanding and emotional support from other close family members

75 Not enough understanding and emotional support from friends

76. Attending religious services or functions
77. Fulfilling domestic/household responsibilities
78. Finding time for entertainment and recreational activities

SECTION IV
HEALTH AND WELL-BEING

A	B	C	D
Almost never	Quite seldom	Quite often	Almost always

Choose the best answer that indicates how frequently you experience the following:

79. How often is your appetite disturbed?

80. How often do you have to watch what you eat to avoid stomach upsets?

81. How often do you feel nauseous?

82. How often do you suffer from heartburn or stomach-ache?

83. How often do you complain of digestion difficulties?

84. How often do you suffer from bloated stomach or flatulence?

85. How often do you suffer from pain in your abdomen?

86. How often do you suffer from constipation or diarrhea?

87. How often do you suffer from heart palpitations?

88. How often do you suffer from aches and pains in your chest?

89. How often do you suffer from dizziness?

90. How often do you suffer from sudden rushes of blood to your head?

91. Do you suffer from shortness of breath when climbing the stairs normally?

92. How often have you been told that you have high blood pressure?

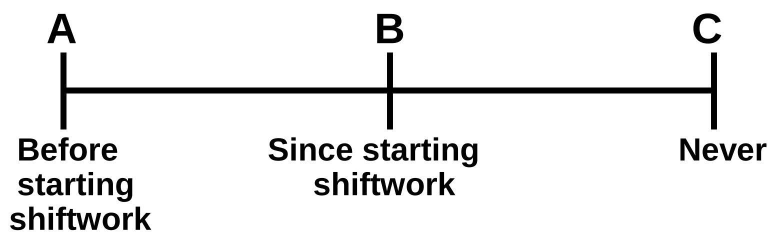
93. Have you ever been aware of your heart beating irregularly?

94. Do you suffer from swollen feet?

95. How often do you feel “tight” in your chest?

96. Do you feel you have put on too much weight since beginning shiftwork?

97. Do you feel you have lost too much weight since beginning shiftwork?



Have you suffered from any of the following **(<u>DIAGNOSED BY YOUR DOCTOR</u>)?**

98. Chronic back pain
99. Gastritis, duodenitis
100. Gastric or duodenal ulcer
101. Gall stones
102. Colitis
103. Sinusitis, tonsillitis
104. Bronchial asthma
105. Angina
106. Severe heart attack (myocardial infarction)
107. High blood pressure
108. Cardiac arrhythmias
109. High cholesterol
110. Diabetes
111. Cystitis
112. Kidney stones
113. Eczema
114. Chronic anxiety
115. Depression
116. Arthritis
117. Hemorrhoids
118. Varicose veins
119. Anemia
120. Headaches

Please list any other diagnoses in "comments" section at end of survey.

A	B	C	D	E
0	1-3	4-6	7-9	10 or More

Please indicate your **CURRENT** daily consumption **(ON AVERAGE)** for the substances below:

121. During a 24-hour period how many **allergy tablets** do you generally take **(i.e., Seldane, Histapan, Allerest, Sinutabs, etc.)**?

122. During a 24-hour period how many **cups of caffeinated coffee or tea** do you drink?

123. During a 24-hour period how many **cups or cans of caffeinated soda** do you drink?

124. During a 24-hour period how many **pain relievers** do you generally use (i.e., **Excedrin, Vanquish, Cope, Empirin, Anacin, Midol, etc. and/or prescription pain relievers**)?

125. During a non-working 24-hour period how many **drinks of alcohol** do you have?

126. During a **ONE MONTH** period, how often do you take **antacids** or prescribed medication for indigestion, heartburn, or ulcers?

---

127. How many **sick and/or personal days** did you take off during the **past four months**?

a. 0
b. 1 - 2
c. 3 - 4
d. 5 - 6
e. 7 or more

128. Have you ever been late for an appointment or work?

a. Yes
b. No

129. Once in a while do you lose your temper and get angry?

a. Yes
b. No

130. Do you **smoke** cigarettes/cigars/pipes or chew tobacco?

a. Yes, the equivalent of more than two packs of cigarettes a day
b. Yes, the equivalent of between one and two packs of cigarettes a day
c. Yes, the equivalent of less than one pack of cigarettes a day
d. No

131. Do you **exercise** on a regular basis (at least weekly)?

a. Yes, at least three times per week
b. Yes, once or twice per week
c. Yes, less than once per week
d. No, I do not exercise

132. About how long do you usually exercise for at one time?

a. Around 5 minutes or less
b. Around 10 minutes
c. Around 20 minutes
d. More than 20 minutes
e. I do not exercise

133. Are all your habits good and desirable ones?

a. Yes
b. No

The following questions deal with **how you have felt in general over the past few weeks.** Remember to concentrate on present and recent complaints, not those that you had in the distant past.

Have you recently: (over the **past few weeks**)	**A**	**B**	**C**	**D**
134. been able to concentrate on what you are doing?	Better than usual	Same as usual	Less than usual	Much less than usual
135. lost much sleep over worry?	Not at all	No more than usual	Rather more than usual	Much more than usual
136. felt that you are playing a useful part in things?	More so than usual	Same as usual	Less than usual	Much less than usual
137. felt capable of making decisions about things?	More so than usual	Same as usual	Less than usual	Much less than usual
138. felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual
139. felt you could not overcome your difficulties?	Not at all	No more than usual	Rather more than usual	Much more than usual
140. been able to enjoy your normal day to day activities?	More so than usual	Same as usual	Less than usual	Much less than usual
141. been able to face up to your problems?	More so than usual	Same as usual	Less than usual	Much less than usual
142. been feeling unhappy and depressed?	Not at all	No more than usual	Rather more than usual	Much more than usual
143. been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
144. been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
145. been feeling reasonably happy all things considered?	More so than usual	Same as usual	Less than usual	Much less than usual

SECTION V

SLEEP, ALERTNESS, AND SAFETY

The following questions will provide information about how your internal clock (circadian rhythms) and sleep management relate to your **current schedule**.

A	B	C	D	E
Less Than 5 Hours	5 Hours	6 Hours	7 Hours	8 or More Hours

146. How many hours of sleep per 24-hour period do you feel you **need** to feel alert and well-rested?

147. How many hours of sleep per 24-hour period are you **actually getting,** on average, during days that you work?

148. How many hours of sleep per 24-hour period are you **actually getting**, on average, **during your days off**?

A	B	C	D	E
Several Times per Day	Several Times Per Week	Several Times Per Month	Several Times Per Year	Seldom, if Ever

149. How often do you briefly nod-off or fall asleep **while working** your **current schedule**?

150. How often do you briefly nod-off, or fall asleep **while driving** to and from work on your **current schedule**?

151. How often do you make **mistakes or mental errors** while working on your **current schedule**?

152. How often do you experience **muscular pain or discomfort** while working on your **current schedule**?

153. How often do you feel **fatigued** while working on your **current schedule**?

Please check to make sure that the question number *matches* the number on the score sheet.

A	B	C	D	E
0	1	2	3	4 or More

154. How many **automobile accidents** did you have in the past **four months**?

155. How many **automobile <u>near</u> accidents** did you have in the past **four months**?

156. During the past **four months**, how many **accidents, errors or injuries** have you had **on the job**?

157. During the past **four months**, how many **<u>near</u> accidents, errors or injuries** have you had **on the job**?

158. Altogether, how many **lost days** have you had in the past **four months** as a result of any accidents or injuries?

---

159. Were any of these accidents or injuries due to **fatigue** or **lack of alertness**?

a. Yes, mostly due to fatigue
b. Yes, in part due to fatigue
c. No, not due to fatigue
d. Does not apply

160. How would you rate the **quality of sleep** that you are getting when working shifts on your **current schedule**?

a. Excellent
b. Good
c. Average
d. Somewhat below average
e. Poor

161. Do you **feel best** (awake, alert, energetic, etc.) in the morning or evening?

a. Morning
b. Evening
c. No difference morning or evening

SECTION VI
STRESS MANAGEMENT

A	B	C	D	E
Strongly Agree	**Agree**	**No Preference**	**Disagree**	**Strongly Disagree**

162. I am responsible for how well I sleep when working shifts.

163. My own behavior influences the extent to which my social life is interfered with when on shifts.

164. When working shifts I can influence my performance.

165. I control whether or not my health is harmed when I work shifts.

166. My physical well-being depends on how well I take care of myself when I work shifts.

167. When on shifts I determine whether or not I get good results at work.

168. When on shifts I have control over the quality of sleep I get.

169. I am directly responsible for the quality of my social life when I am working shifts.

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170. **Before this process began** (task team, videos, survey, voting on schedules, implementing selected schedules, training, etc.), how much control do you think you had in managing your overall life?
    a. No control
    b. Very little control
    c. Some control
    d. A lot of control
    e. Complete control

171. **As a result of this process** (task team, videos, survey, voting on schedules, implementing selected schedules, training, etc.) how much control do you think **you now have** in managing your overall life?
    a. No control
    b. Very little control
    c. Some control
    d. A lot of control
    e. Complete control

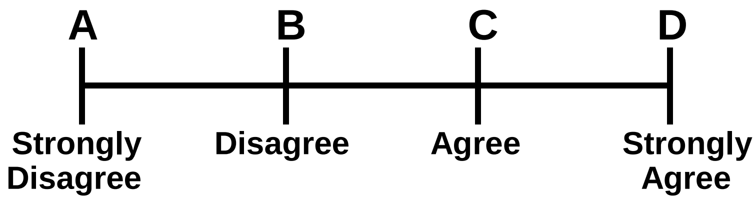
172. Do you sometimes talk about things you know nothing about?

    a. Yes
    b. No

A	B	C	D
I haven't been doing this at all	**I've been doing this a little bit**	**I've been doing this a medium amount**	**I've been doing this a lot**

Everyone has to manage stress in their lives, and there are many ways to try to deal with problems. Each of the following items says something about a particular way of coping. Indicate the extent to which you **currently usually or typically** do each of the things listed when under stress. Don't answer on the basis of whether it seems to be working or not just whether or not you're doing it. Choose the one **BEST** answer for each item on this page, and please make your choice **as true FOR YOU as you can**.

173. I've been turning to work or other activities to take my mind off things.
174. I've been concentrating my efforts on doing something about the situation I'm in.
175. I've been saying to myself "this isn't real."
176. I've been using alcohol or other drugs to make myself feel better.
177. I've been getting emotional support from others.
178. I've been giving up trying to deal with it.
179. I've been taking action to try to make the situation better.
180. I've been refusing to believe that it has happened.
181. I've been saying things to let my unpleasant feelings escape.
182. I've been using alcohol or other drugs to help me get through it.
183. I've been trying to see it in a different light, to make it seem more positive.
184. I've been trying to come up with a strategy about what to do.
185. I've been getting comfort and understanding from someone.
186. I've been giving up the attempt to cope.
187. I've been looking for something good in what is happening.
188. I've been making jokes about it.
189. I've been doing something to think about it less, such as going to movies, watching TV, reading, daydreaming, sleeping, or shopping.
190. I've been accepting the reality of the fact that it has happened.
191. I've been expressing my negative feelings.
192. I've been trying to find comfort in my religion or spiritual beliefs.
193. I've been focusing on something else important if I couldn't solve this problem.
194. I've been trying to get advice from someone about what to do.
195. I've been putting aside other activities in order to concentrate on this.
196. I've been learning to live with it.
197. I've been thinking hard about what steps to take.
198. I've been praying or meditating.
199. I've been making fun of the situation.
200. I've been talking to someone to find out more about the situation.
201. I've been trying to keep myself from getting distracted by other thoughts or activities.
202. I've been finding another way to be productive during this situation if I couldn't completely solve the problem.



203. My job requires that I learn new things.

204. My job involves a lot of repetitive work.

205. My job requires me to be creative.

206. My job allows me to make a lot of decisions on my own.

207. My job requires a high level of skill.

208. On my job, I have very little freedom to decide how I do my work.

209. I get to do a variety of different things on my job.

210. I have a lot to say about what happens on my job.

211. I have an opportunity to develop my own special abilities.

212. My job requires working very fast.

213. My job requires working very hard.

214. My job requires lots of physical effort.

215. I am not asked to do an excessive amount of work.

216. I have enough time to get the job done.

217. I am often required to move or lift very heavy loads on my job.

218. My work requires rapid and continuous physical activity.

219. I am free from conflicting demands that others make.

220. My job requires long periods of intense concentration on the task.

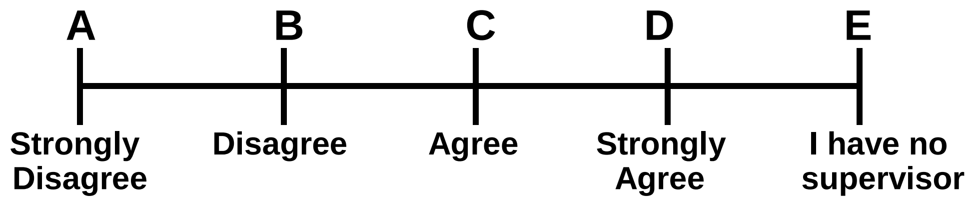
221. My tasks are often interrupted before they can be completed, requiring attention at a later time.

222. My job is very hectic.

223. I am often required to work for long periods with my body in physically awkward positions.

224. I am required to work for long periods with my head or arms in physically awkward positions.

225. Waiting on work from other people or departments often slows me down on my job.



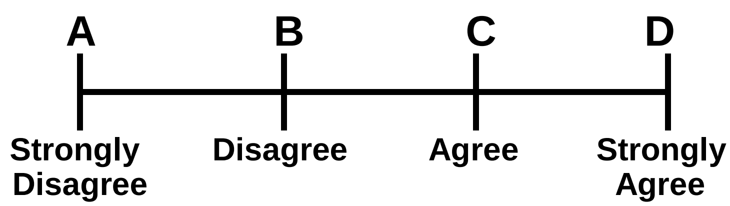
226. My supervisor is concerned about the welfare of those under him/her.

227. My supervisor pays attention to what I am saying.

228. I am exposed to hostility or conflict from my supervisor.

229. My supervisor is helpful in getting the job done.

230. My supervisor is successful in getting people to work together.



231. Of all the people I know there are some whom I definitely do not like.

232. People I work with take a personal interest in me.

233. I sometimes gossip.

234. I am exposed to hostility or conflict from the people I work with.

235. I occasionally have thoughts and ideas that I would not want other people to know about.

236. People I work with are friendly.

237. I would always declare everything at customs even if I knew that I could never be found out.

238. The people I work with encourage each other to work together.

239. People I work with are competent in doing their jobs.

240. People I work with are helpful in getting the job done.

Appendix C: Subject Validity Criteria & Process

- Of approximately 2020 potential participants, 1727 employees completed at least one of two surveys administered approximately 12 months apart.
- Of the 1416 employees who filled out Survey I, 90 did not correctly encode their anonymous identification number.
- Of the remaining 1326 Survey I respondents, 495 either did not take Survey II or did not properly enter their anonymous identification number in Survey II.
- Of the 1316 employees who completed Survey II, 92 did not correctly encode their anonymous identification number.
- Of the remaining 1224 Survey II respondents, 393 either did not take Survey I or did not properly enter their anonymous identification number in Survey I. Thus 831 employees completed both Surveys I and II and also correctly entered their anonymous identification number on both answer sheets.
- Of these 831 employees, 106 did not meet the criteria established for the present study using the Eysenck Lie (validity) Scale contained in the Eysenck Personal Inventory Manual, Form A-1 (Eysenck and Eysenck, 1968; Appendix A presents the validity scale along with other survey measures and Appendix C explains the rationale to determine the validity cutoff point in the present study). A total of 725 employees therefore met the first three selection criteria.

- 31 of these employees did not correctly identify their primary work function in at least one of the two surveys, trimming the potential participant pool to 694 according to the first four subject criteria.
- Finally, 91 of the remaining employees did not provide identical responses to gender and/or ethnicity items on both surveys. Thus, 603 shiftworkers qualified as valid subjects and served as the sample population in the present study.

Rationale to Determine Cutoff Point in Eysenck Validity Scale

Generally, Eysenck suggests when using this validity scale (see Appendix A) to accept those subjects who endorse at least six of nine "valid" responses, although the cutoff point is somewhat arbitrary. Although the cutoff employed in the present study is less exclusive than Eysenck's suggested criteria, the selected metric does retain a reasonable percentage of the sample (87.2%). This choice seems appropriate given that allowing only two valid responses would produce a subject pool with an unacceptable potential for invalid response patterns (95.7%), while requiring a minimum of four valid responses would likely exclude a meaningful number of subjects that generally did respond to the survey in a valid manner, thus including too low a percentage of valid response patterns (74.0%).

One possible explanation for the tendency in the present study to endorse validity scale items in a way that at first blush appear to suggest potential confound is the somewhat unique characterization of the sample pool with regard to levels of religious involvement and general beliefs concerning people and behavior. Anecdotally, during the experimenter's numerous site visits throughout the schedule redesign and training process, many of the subjects volunteered unsolicited comments regarding their consistent belief in always telling the truth and liking all those around them, even though this may be inconsistent with population beliefs at large and could yield an invalid response on a number of Eysenck validity scale items.

For example, one validity scale item asks, "Would you always declare everything at customs, even if you knew that you could never be found out"? Having spoken with many subjects who volunteered their deep religious beliefs, endorsement of this question for many in this population may tend to be less indicative of an invalid response pattern and more an indication of the honest belief that one would in this situation declare his or her goods. By excluding 12.8% of the potential sample, the present study does attempt to minimize analysis of subject data with the greatest potential for invalid response patterns while still including those most likely to respond with acceptable levels of veracity.

OSHA 200 Log Form: Log and Summary of Occupational Injuries and Illnesses

Instructions for OSHA No. 200

I. Log and Summary of Occupational Injuries and Illnesses

Each employer who is subject to the recordkeeping requirements of the Occupational Safety and Health Act of 1970 must maintain for each establishment, a log of all recordable occupational injuries and illnesses. This form (OSHA No. 200) may be used for that purpose. A substitute for the OSHA No. 200 is acceptable if it is as detailed, easily readable, and understandable as the OSHA No. 200.

Enter each recordable case on the log within six (6) workdays after learning of its occurrence. Although other records must be maintained at the establishment to which they refer, it is possible to prepare and maintain the log at another location, using data processing equipment if desired. If the log is prepared elsewhere, a copy updated to within 45 calendar days must be present at all times in the establishment.

Logs must be maintained and retained for five (5) years following the end of the calendar year to which they relate. Logs must be available (normally at the establishment) for inspection and copying by representatives of the Department of Labor, or the Department of Health and Human Services, or States accorded jurisdiction under the Act. Access to the log is also provided to employees, former employees and their representatives.

II. Changes in Extent of or Outcome of Injury or Illness

If, during the 5-year period the log must be retained, there is a change in an extent and outcome of an injury or illness which affects entries in columns 1, 2, 6, 8, 9, or 13, the first entry should be lined out and a new entry made. For example, if an injured employee at first required only medical treatment but later lost workdays away from work, the check in column 6 should be lined out and checks entered in columns 2 and 3 and the number of lost workdays entered in column 4.

In another example, if an employee with an occupational illness lost workdays, returned to work, and then died of the illness, any entries in columns 9 through 12 would be lined out and the date of death entered in column 8.

The entire entry for an injury or illness should be lined out if later found to be nonrecordable. For example, an injury which is later determined not to be work related, or which was initially thought to involve medical treatment but later was determined to have involved only first aid.

III. Posting Requirements

A copy of the totals and information following the total line of the last page for the year, must be posted at each establishment in the place or places where notices to employees are customarily posted. This copy must be posted no later than February 1 and must remain in place until March 1. Even though there were no injuries or illnesses during the year, zeros must be entered on the totals line, and the form posted.

The person responsible for the annual summary totals shall certify that the totals are true and complete by signing at the bottom of the form.

IV. Instructions for Completing Log and Summary of Occupational injuries and illnesses

Column A - CASE OR FILE NUMBER. Self Explanatory

Column B - DATE OF INJURY OR ONSET OF ILLNESS
For occupational injuries, enter the date of the work accident which resulted in the injury. For occupational illnesses, enter the date of initial diagnosis of illness, or, if absence from work occurred before diagnosis, enter the first day of the absence attributable to the illness which was later diagnosed or recognized.

Columns C through F - Self Explanatory

Columns 1 and 8 - INJURY OR ILLNESS-RELATED DEATHS - Self Explanatory

Columns 2 and 9 - INJURIES OR ILLNESSES WITH LOST WORKDAYS - Self Explanatory
Any injury which involves days away from work, or days of restricted work activity, or both, must be recorded since it always involves one or more of the criteria for recordability.

Columns 3 and 10 - INJURIES OR ILLNESSES INVOLVING DAYS AWAY FROM WORK - Self Explanatory

Columns 4 and 11 - LOST WORKDAYS -- DAYS AWAY FROM WORK.
Enter the number of workdays (consecutive or not) on which the employee would have worked but could not because of occupational injury or illness. The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work. NOTE: For employees not having a regularly scheduled shift, such as certain truck drivers, construction workers, farm labor, casual labor, part-time employees, etc., it may be necessary to estimate the number of lost workdays. Estimates of lost workdays shall be based on prior work history of the employee AND days worked by employees, not ill or injured, working in the department and/or occupation of the ill or injured employee.

Columns 5 and 12 - LOST WORKDAYS -- DAYS OF RESTRICTED WORK ACTIVITY.
Enter the number of workdays (consecutive or not) on which because of injury or illness:
(1) the employee was assigned to another job on a temporary basis, or
(2) the employee worked at a permanent job less than full time, or
(3) the employee worked at a permanently assigned job but could not perform all duties normally connected with it.

The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work.

Columns 6 and 13 - INJURIES OR ILLNESSES WITHOUT LOST WORKDAYS - Self Explanatory

Columns 7a through 7g - TYPE OF ILLNESS. Enter a check in only *one* column for each illness.
TERMINATION OR PERMANENT TRANSFER - Place an asterisk to the right of the entry in columns 7a through 7g (type of illness) which represented a termination of employment or permanent transfer.

V. Totals
Add number of entries in columns 1 and 8.
Add number of checks in columns 2, 3, 6, 7, 9, 10 and 13.
Add number of days in columns 4, 5, 11 and 12.
Yearly totals for each column (1-13) are required for posting. Running or page totals may be generated at the discretion of the employer.

In an employee's loss of workdays is continuing at the time the totals are summarized, estimate the number of future workdays the employee will lose and add that estimate to the workdays already lost and include this figure in the annual totals. No further entries are to be made with respect to such cases in the next year's log.

VI. Definitions
OCCUPATIONAL INJURY is any injury such as a cut, fracture, sprain, amputation, etc. which results from a work accident or from an exposure involving a single incident in the work environment. NOTE: Conditions resulting from animal bites, such as insect or snake bites or from one-time exposure to chemicals, are considered to be injuries.

OCCUPATIONAL ILLNESS of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases which may be caused by inhalation, absorption, ingestion, or direct contact.

The following listing gives the categories of occupational illnesses and disorders that will be utilized for the purpose of classifying recordable illnesses. For purposes of information, examples of each category are given. These are typical examples, however, and are not to be considered the complete listing of the types of illnesses and disorders that are to be counted under each category.

7a. Occupational Skin Diseases or Disorders. Examples: Contact dermatitis, eczema, or rash caused by primary irritants and sensitizers or poisonous plants; oil acne; chrome ulcers; chemical burns or inflammation, etc.

7b. Dust Diseases of the Lungs (Pneumaconioses). Examples: Silicosis, asbestosis and other asbestos-related diseases, coal worker's pneumaconioses, byssinosis, siderosis, and other pneumaconioses.

7c. Respiratory Conditions Due to Toxic Agents. Examples: Pneumonitis, pharyngitis, rhinitis or acute congestion due to chemicals, dusts, gases, or fumes; farmer's lung; etc.

7d. Poisoning (Systemic Effects of Toxic Materials). Examples: Poisoning by lead, mercury, cadmium, arsenic, or other metals; poisoning by carbon monoxide, hydrogen sulfide, or other gases; poisoning by benzol, carbon tetrachloride, or other organic solvents; poisoning by insecticide sprays such as parathion, lead arsenate; poisoning by other chemicals such as formaldehyde, plastics, and resins; etc.

7e. Disorders Due to Physical Agents (Other than Toxic Materials). Examples: Heatstroke, sunstroke, heat exhaustion, and other effects of environmental heat, freezing, frostbite, and effects of exposure to low temperatures; caisson disease; effects of ionizing radiation (isotopes, X-rays, radium); effects of nonionizing radiation (welding flash, ultraviolet rays, microwaves, sunburn); etc.

7f. Disorders Associated with Repeated Trauma. Examples: Noise-induced hearing loss; synovitis, tenosynovitis, and bursitis. Raynaud's phenomena; and other conditions due to repeated motion, vibration, or pressure.

7g. All Other Occupational Illnesses. Examples: Anthrax, brucellosis, infectious hepatitis, malignant and benign tumors, food poisoning, histoplasmosis, coccidioidomycosis, etc.

MEDICAL TREATMENT includes treatment (other than first aid) administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does NOT include first aid treatment (one-time treatment and subsequent observation of minor scratches, cuts, burns, splinters, and so forth, which do not ordinarily require medical care) even though provided by a physician or registered professional personnel.

ESTABLISHMENT: A single physical location where business is conducted or where services or industrial operations are performed (for example: a factory, mill, store, hotel, resturant, movie theater, farm, ranch, bank, sales office, warehouse, or central administrative office).
Where distinctly separate activities are performed at a single physicial location, such as construction activities operated from the same physical locations as a lumber yard, each activity shall be treated as a separate establishment.

For firms engaged in activities which may be physically dispersed, such as agriculture; construction; transportation; communications and electric, gas, and sanitary services, records may be maintained at a place to which employees report each day.

Records for personnel who do not primarily report or work at a single establishment, such as traveling salesmen, technicians, engineers, etc., shall be maintained at the location from which they are paid or the base from which personnel operate to carry out their activities.

WORK ENVIRONMENT is comprised of the physical location, equipment, materials processed or used, and the kinds of operations performed in the course of an employee's work, whether on or off the employer's premises.

Employee-Selected Schedule: Fixed 12-hour 2-2-3

CREW	Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Day Crew 1	1	D	D	-	-	D	D	D
	2	-	-	D	D	-	-	-
	3	D	D	-	-	D	D	D
	4	-	-	D	D	-	-	-

CREW	Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
DAY Crew 2	1	-	-	D	D	-	-	-
	2	D	D	-	-	D	D	D
	3	-	-	D	D	-	-	-
	4	D	D	-	-	D	D	D

CREW	Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Night Crew 3	1	N	N	-	-	N	N	N
	2	-	-	N	N	-	-	-
	3	N	N	-	-	N	N	N
	4	-	-	N	N	-	-	-

CREW	Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Night Crew 4	1	-	-	N	N	-	-	-
	2	N	N	-	-	N	N	N
	3	-	-	N	N	-	-	-
	4	N	N	-	-	N	N	N

Figure 4. Employee-selected work schedule for FAB Tech and Shipping Departments: 4-crew 2-2-3 EOWEO (every other weekend off) fixed 12-hour schedule; start 7am day, 7pm night.

Employee-Selected Schedule: Fixed 8-hour 6-2

Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	X	X	X	X	X	X	-
2	-	X	X	X	X	X	X
3	-	-	X	X	X	X	X
4	X	-	-	X	X	X	X
5	X	X	-	-	X	X	X
6	X	X	X	-	-	X	X
7	X	X	X	X	-	-	X
8	X	X	X	X	X	-	-

Figure 5. Employee-selected work schedule for Primary Tech and Parts Departments: 4-crew 6 on 2 off fixed 8-hour schedule; start 7am day, 3pm evening, 11pm night (X=days on pattern for all crews; start times)

Employee-Selected Schedule: Fixed 12-hour 2-5-5-2

CREW	Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Day Crew 1	1	-	-	D	D	-	-	-
	2	-	-	D	D	D	D	D
	3	-	-	D	D	-	-	-
	4	-	-	D	D	D	D	D

CREW	Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Day Crew 2	1	D	D	-	-	D	D	D
	2	D	D	-	-	-	-	-
	3	D	D	-	-	-	-	-
	4	D	D	-	-	D	D	D

CREW	Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Night Crew 3	1	-	-	N	N	-	-	-
	2	-	-	N	N	N	N	N
	3	-	-	N	N	-	-	-
	4	-	-	N	N	N	N	N

CREW	Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Night Crew 4	1	N	N	-	-	N	N	N
	2	N	N	-	-	-	-	-
	3	N	N	-	-	-	-	-
	4	N	N	-	-	N	N	N

Figure 6. Employee-selected work schedule for SFT, SPT, EET, and Supply Departments: 4-crew 2-5-5-2 fixed12-hour schedule; start 7am day, 7pm night.

Table 30. Power Analyses for Significant Tests of Hypotheses Among Primary Variables.

PREDICTORS	OUTCOMES													
	ADJ	PSY	PHYS	PHQ	MED	PERF	SAFE	PROD	PROC	AC	AP	AX	CTRL	SUPP
IMPROVED DEMAND	>.80	>.80	>.80	>.80	>.80	>.80	>.80	>.80	>.80	0.5		0.75	x	x
SCHEDULE PREFERENCE	>.80			0.61		>.80		>.80	>.80	.63*			>.80	>.80
LIFESTYLE TRAINING														
DEMAND x PREFERENCE								>.80	>.80				x	x
PREF x TRAINING														
ADAPTIVE COPING		0.53					0.79						x	x
APPROACH COPING													x	x
AUXILIARY COPING	0.58	>.80				0.73	0.72						x	x
SHIFTWORK LOC	>.80	>.80	>.80	>.80	>.80	>.80	>.80	>.80	>.80			0.64		
SPOUSE/PARTNER SUPPORT	>.80	>.80	>.80	>.80	>.80	>.80	>.80	>.80	>.80			>.80		
CONTROL x SUPPORT	>.80	>.80	0.7	0.73					0.68					

* = one significant finding in unexpected direction
x= not directly predicted in hypothesized, integrative model

Mnemonic for Refined Coping Taxonomy

I	seeking ***Instrumental*** support
P	***Planning***
A	***Active*** coping
C	suppression of ***Competing*** activities
H	***Humor***
A	***Acceptance***
R	***Religion***
P	***Positive*** reinterpretation and growth
S	seeking emotional ***Social*** support
B	***Behavioral*** disengagement
E	venting of ***Emotions***
M	***Mental*** disengagement
A	***Alcohol***/drug use
D	***Denial***

Figure 28. Mnemonic for refined coping taxonomy to include auxiliary coping using Carver's (1989) COPE subscales partitioned into approach, auxiliary, and avoidance sub groupings.

Approach: IPAC:"I pack a (proverbial) wallop when I approach this problem."

Auxiliary: HARPS:"I can't do anything to change this right now (if at all). I don't want to just forget it or hide from it, so why not instead take comfort in accepting it and dealing with it in a positive, soothing way which will relax me and help me prepare to better address the problem directly when I can actually do something about it."

Avoidance: BE MAD:"Just being mad rarely gets me anywhere."

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Vita

Andrew Marshall Lehrer was born on February 22, 1962, the son of Sandra Lehrer and Ronald Michael Lehrer. After winning first place in the National High School Mathematics Exam among Sharon High School Juniors, he graduated as the Salutatorian of Sharon High School, Sharon, MA in 1980, receiving the Harold Glendenning Memorial Award and the Foreign Language Award for Spanish. He attended the University of Massachusetts at Amherst as a Board of Higher Education Massachusetts State Commonwealth Scholar and studied psychology, neuroscience, and music. He was elected Vice President of CUSP, the University's Council of Undergraduate Students in Psychology, and was inducted into Psi Chi, the National Honor Society in Psychology. In 1983 he was selected as an International Student Exchange Program Scholar and attended Flinders University of South Australia's Centre for Neuroscience. He received a Bachelor of Science in Psychology with both Departmental and University Honors in May 1985. In 1993 he entered the Graduate School at The University of Texas at Austin, was a National Science Foundation HM award recipient in Health Psychology, graduated with a Master of Arts in Clinical Psychology in May, 1996, and was inducted into Phi Kappa Phi, the Graduate National Honor Society. He has worked in the field of shiftwork optimization for over 12 years and has served as a member of the National Academy of Sciences Transportation Safety Board's subcommittee on Rail Human Factors, and as Vice President at an international consulting firm. He has assisted more than half of the Fortune 500 to optimize 24/7 performance, safety, and health, and has worked extensively throughout North America as well as the U.K., Scotland, Jamaica, Ireland, and Wales. He has served on numerous boards and committees across industry and public service, has been a frequent keynote speaker at national & international conferences, taught, published in industry, and has appeared on television and radio, including a feature with NBC Dateline. He is also an avid guitarist and award winning published lyricist & composer, having written over 100 songs. He is currently pursuing a doctorate in Psychology at the University of Texas at Austin.

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